PUBLICATION 757
TECHNICAL BULLETIN 48

PUBLISHED MARCH, 1944

DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

SOIL SURVEY

of the

WOODSTOCK AREA

NEW BRUNSWICK

by

P. C. STOBBE and H. AALUND

SECOND REPORT OF THE
NEW BRUNSWICK
SOIL SURVEY

EXPERIMENTAL FARMS SERVICE
DOMINION DEPARTMENT OF AGRICULTURE
IN CO-OPERATION WITH THE NEW BRUNSWICK
DEPARTMENT OF AGRICULTURE

Published by Authority of the Hon. JAMES G. GARDINER, Minister of Agriculture, Ottawa

3M—7168-3:44

PUBLICATION 757
TECHNICAL BULLETIN 48

PUBLISHED MARCH, 1944

DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

SOIL SURVEY

of the

WOODSTOCK AREA

NEW BRUNSWICK

by

P. C. STOBBE and H. AALUND

SECOND REPORT OF THE
NEW BRUNSWICK
SOIL SURVEY

EXPERIMENTAL FARMS SERVICE
DOMINION DEPARTMENT OF AGRICULTURE
IN CO-OPERATION WITH THE NEW BRUNSWICK
DEPARTMENT OF AGRICULTURE

Published by Authority of the Hon. JAMES G. GARDINER, Minister of Agriculture, Ottawa

3M—7168-3 :44

ACKNOWLEDGMENT

THE soil survey of the Woodstock area was conducted by the Experimental Farms Service, Dominion Department of Agriculture in co-operation with the New Brunswick Department of Agriculture. The University of New Brunswick provided headquarters and laboratory accommodations for the analytical work.

The field work was carried out by Messrs. H. Aalund, A. Briggs, K. K. Langmaid, L. MacKay, and Dr. F. J. Toole, under the direction of Mr. P. C. Stobbe; while the chemical and physical analysis were conducted by Messrs. H. Aalund and K. K. Langmaid.

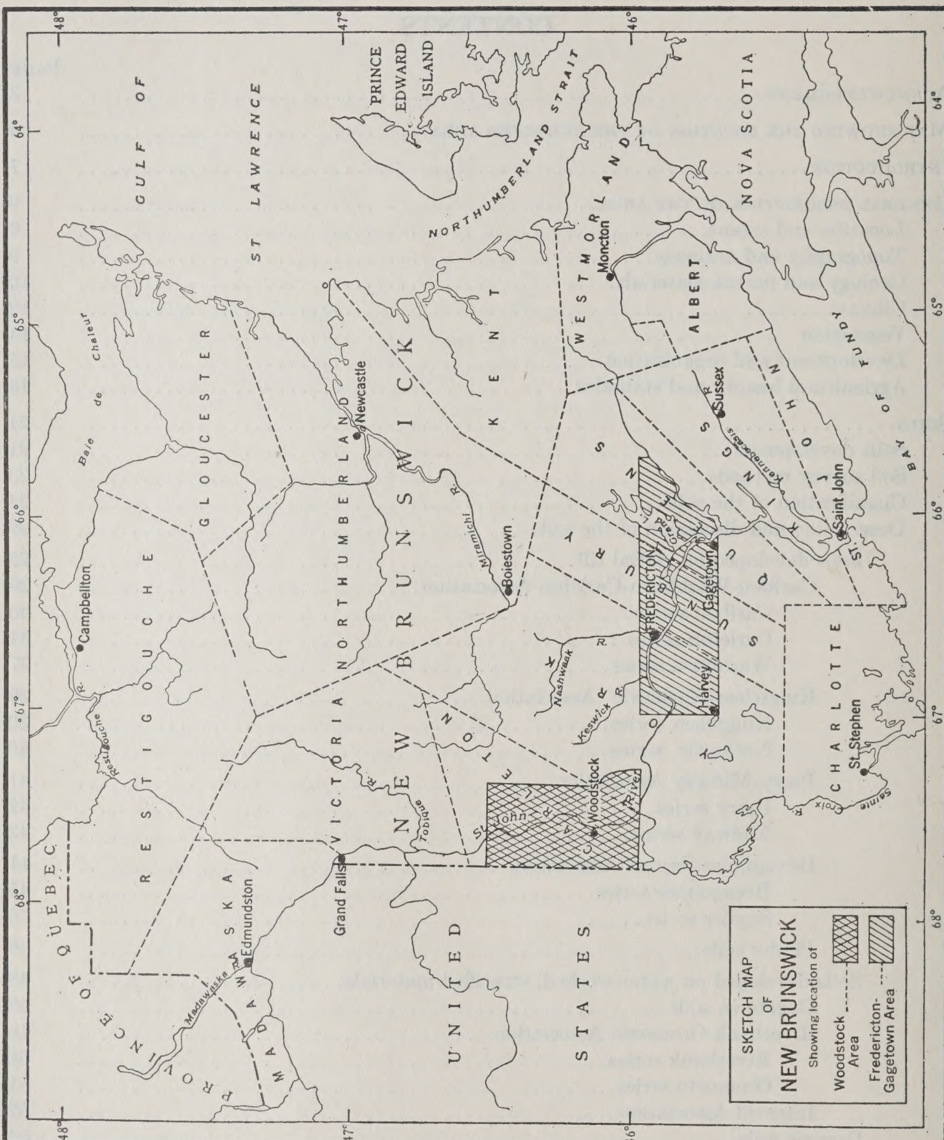
The authors wish to acknowledge assistance received from Mr. R. M. Maxwell, Director, Carleton County Vocational School, from Mr. A. E. Raymond, New Brunswick Department of Agriculture, and from many other members of the Provincial and Dominion Departments of Agriculture.

Acknowledgment is also gratefully given to Dr. W. J. Wright, Provincial Geologist, for information regarding the geology of the area, and to Dr. F. J. Toole, Professor of Chemistry, University of New Brunswick, for his continued interest in the work, and assistance in chemical analysis.

Thanks are due to Dr. A. Leahey, Soil Specialist, Central Experimental Farm, Ottawa, for constructive criticism of the report.

The Dominion Department of Mines and Resources, Survey and Engineering Branch, Hydrographic and Map Service supervised the compilation and drawing of the soil map.

CONTENTS



Map published by the Experimental Farms Service, Ottawa

INTRODUCTION

Soil survey work in New Brunswick was started in 1938 as a co-operative project by the Experimental Farms Service, Dominion Department of Agriculture, and the New Brunswick Department of Agriculture.

At the request of the potato growers in Carleton and Victoria counties, a soil survey was made of the Woodstock area in 1939. The Woodstock area as referred to in this report occupies most of Carleton and part of York counties. It is one of the most densely settled and most extensively cultivated farm areas of the province, in which a certain amount of specialization has taken place, and where commercial potato growing is an important feature of farm operations.

The main purpose of a soil survey is to classify and map the soils of an area according to their inherent physical and chemical characteristics. The interpretation of these characteristics in terms of productivity and agricultural adaptability of the respective soils is also an important feature of the soil survey program.

The information obtained from the survey of the Woodstock area is presented in this report, which is the second soil survey report for the province. It provides an inventory of the soils and of soil conditions in the map area. Every soil type is described in considerable detail. The first part of each description deals with the characteristics by which the soil may be recognized, while the second part discusses the soil in relation to agriculture. The report also gives a brief description of the general map area and describes climatic, topographic, geological, and other factors which have a close bearing on soil development and crop production. The soils are grouped in a general classification scheme, and they have also been rated tentatively according to their suitability for the production of various agricultural crops.

The soil map, which is printed on the scale of two mile to one inch, is an important part of this report. It shows the location and extent of the different soil types and indicates the most important physical features of the area, such as roads, railways, rivers, towns, houses, etc.

The soil survey report together with the enclosed map provides much useful information to the practical farmer, the extension man, and the research worker. With the information that such a survey affords, every farmer or landowner in the surveyed area has at hand a basis for systematic improvement and maintenance of his land. The information serves as a valuable guide to the extension worker whose duty it is to advise farmers on problems related to soil fertility and crop production. It also provides a fundamental basis for the scientific investigator on which he can proceed intelligently to plan those fundamental investigations so necessary for the solution of problems in practical soil improvement.

SOIL SURVEY

of

WOODSTOCK AREA, N.B.

GENERAL DESCRIPTION OF THE DISTRICT

Location and Extent

The Woodstock area was surveyed during the summer of 1939. It includes most of Carleton and a small corner of York counties and covers approximately 780 square miles or 500,000 acres.

The general location of this area is indicated on the sketch map on page 6. Its exact boundaries are: on the west, the International Boundary (State of Maine) from 46° 00′ to 46° 30′ latitude; on the north, a line along 46° 30′ latitude running straight east-west a short distance above Knoxford, Bristol, Gordonsville, and Highlands; on the east, a line running due north-south approximately one mile east of East Knowlesville, till it strikes the C.P.R. railway some $2\frac{1}{2}$ miles northwest of Nackawic station, then along the railway to the Nackawic river, and following the latter to the southern boundary of the map area; on the south, a line due east-west along 46° 00′ latitude, crossing the St. John river near the mouth of Greer's creek and immediately north of the village of Meductic.

The St. John river bisects the area roughly from north to south and at the southern extremity of the area turns sharply to follow a southeasterly course to Fredericton, a distance of 55 miles.

Topography and Drainage

The surveyed area is entirely within the drainage basin of the St. John and its tributaries. Most of the tributaries, such as the Shiktahawk, Presquile, Little Presquile, Meduxnekeag, and Becaguimec rivers, and Acker brook have cut deep, narrow valleys, which enter the St. John at almost right angles, forming an open, tree-like pattern. The St. John valley attains a width of more than one mile, near Woodstock, but becomes narrower towards the north. In the wide stretches, the St. John river is flanked by fairly large flats, which are subject to periodic flooding, but in the narrow parts it occupies practically the whole valley bottom. The country rises steeply on either side of the river to an average elevation of about 300 feet above the valley bottom within a distance of about three-quarters of a mile from the river.

The area under consideration presents considerable diversity with regard to physical features. Speaking broadly, the region on the northwest side of a line running diagonally from the southwest corner of the map to South Knowlesville in the northeast corner forms a moderately elevated plateau having a height above sea level of about 400 to 500 feet. This section of the area has generally an undulating to gently rolling topography, which is broken by the narrow deep valleys of the tributaries of the St. John and by a few more or less isolated hills with fairly steep slopes. Because of the undulating surface and the porous nature of the soil both external and internal drainage conditions are good. Hill-

side seepage is seldom encountered, but some depressional areas without a drainage outlet occur in which drainage conditions of the soil are poor. This part of the map area is largely cleared of forest and is under cultivation.

The land southeast of the diagonal is more rugged than the northwestern section with an average elevation well above 500 feet. The topography generally varies from undulating to rolling, but is broken by steep hills and long ridges, many of which are very stony and have numerous rock outcrops. Between the ridges, there are often quite large tracts of level to depressional land, which is usually poorly drained and covered with a stunted, tangled growth of trees. This portion of the map area is largely under forest, the settlements being for the most part small and scattered.

Small lakes and swamps occur in many of the small depressions and valleys in the surveyed area. The larger peat and muck areas represent former lakes that have been filled, partly by the washing in of mineral material from the surrounding upland and partly by the accumulation of vegetative matter. As a rule, the peats and mucks are of shallow depth, varying from a few inches to several feet.

Geology and Parent Materials of the Soils

The geological surface deposits constitute the parent materials from which the present-day soils have developed, and consequently they have a great influence on the physical and chemical characteristics of the soil and on its fertility. A knowledge of the nature of these deposits is, therefore, essential in the study of the soils.

The entire Woodstock area has been subjected to glaciation, and, as a result, practically all of the upland of this area is covered with a mantle of glacial till, which was left by the retreating ice. The covering of glacial till varies considerably in thickness. In most cases, it is fairly shallow, having an approximate depth of about 3 or 4 feet; however, it is not uncommon to see rock outcrops at the surface, where they were left exposed by the scraping action of the ice or by more recent erosion, while in other instances the till has been seen to extend to a depth of more than 10 feet. As a rule, the till on the higher ridges is thin, and it attains its greatest depth in the depressions.

During the recession of the glacial ice many streams and lakes were formed, which reworked and redeposited much of the glacial material. The largest of such reworked waterlaid deposits are found along the St. John River valley, extending, in some cases, to a distance of one mile from the river banks at elevations considerably above the present river level, and along the tributaries of the St. John. These materials differ from the glacial till in their greater textural uniformity and porosity, and in their chemical composition.

In more recent times fine alluvial material has been deposited on the low, flat land in the river valleys during the high freshets in the spring and after heavy rainstorms. In many places this process of depositions is still going on, and a thin layer of fine sand or silt is being deposited annually or in years of high freshets.

Apparently the glacial till in the Woodstock area was moved over comparatively short distances. This is indicated by the presence in the drift of a large number of comparatively soft rock fragments which were not ground up by the ice, and by the similarity between these rock fragments and the underlying rock formations. This close relationship between the underlying rock formations and the glacial till is evident throughout the area, and in many cases the boundaries between the different kinds of till and the corresponding soils agree fairly closely with those of the underlying rock. There is also some correlation between the geological formations and the topography of the land in this area.

The various formations of bed-rock underlying the Woodstock area are classified into pre-Silurian, Silurian, Devonian, and Carboniferous, the pre-Silurian being the oldest and the Carboniferous the youngest. The pre-Silurian and the Silurian formations occupy the greater part of the area. The diagonal from southwest to northeast across the map area, which separates the undulating land to the northwest from the rolling country to the southeast, also represents the line of contact between the pre-Silurian and the Silurian rocks, the latter occupying the undulating area to the northwest. The two formations, which consist of sedimentary rocks, have been folded and contorted by movements of the earth's crust, the folds being associated with the low ridges which were mentioned in the section on Topography and Drainage. The pre-Silurian strata are composed of quartzites with thin layers of hard, green slates and occasional beds of crystalline limestone. The latter is being quarried about 1½ miles north of Waterville Settlement on the road to Temperance Vale. The Silurian rocks are mainly grey, dark grey, and black, calcareous slates and shales. Limestone beds occur occasionally, and quarries are or have been worked near the head of Limestone Brook in the parish of Brighton and on the right side of the North Becaguimec about one mile above the bridge at Carlisle. The outcrops of the Silurian slates and shales as well as the pre-Silurian slates indicate that the strata are steeply inclined, forming a northwest dip of from 45° to 90°. Due to this position of the bed-rock the numerous small fissures between the thin layers of shale and slate provide excellent internal drainage for the superimposed till and the developed soils.

The rocks of Devonian age are exposed as dykes of small extent in localities scattered over most of the map area; but in the southeast corner, at Campbell Settlement and Temperance Vale, they constitute the immediate bed-rock over an area of about 18 square miles. The dykes consist chiefly of diabase and syenite, whereas the rock of the larger area consists of grey to reddish, rather coarse-textured granite; it is an isolated part of the long, narrow formation of granitic rocks stretching across the province from the Chiputneticook Lakes towards Bathurst.

Rocks of the Carboniferous age underlie approximately 70 square miles on the east side of the St. John river, where they occupy a roughly triangular area in the parish of Brighton. The beds of Carboniferous rocks are nearly flat-lying; they consist chiefly of chocolate to red coloured calcareous conglomerate and fine-grained sandstone and of non-calcareous, dark brown to reddish brown conglomerate, coarse-grained sandstone and sandy shale.

The parent materials of the soils in the surveyed area may be summarized as follows, according to the nature and the mode of deposition of the surface deposits:—

1. The larger part of the area is covered with grey glacial till, which has been derived mainly from Silurian and pre-Silurian, calcareous slates and shales. In the northwestern section the till consists largely of Silurian material and contains a large amount of soft and crumbly shale and slate fragments. Towards the centre of the area, the soft Silurian shale fragments in the soil become scarce, and the percentage of pre-Silurian rock fragments in the soil increases, until they gain complete predominance in the eastern and southern parts of the map area. The till varies in texture from a loam to clay loam, and is quite friable and fairly high in lime. In cases where the till is very shallow, the soil has been formed partly from the weathered residual shale and slate and partly from the till.

2. Glacial till derived largely from brown to reddish Carboniferous materials. It may be subdivided into three distinct groups:—
    (*a*) Calcareous, red, stony clay loam till from calcareous, red conglomerate and fine-grained sandstone.
    (*b*) Dark brown to reddish brown slightly modified stony till loam from non-calcareous, reddish conglomerate and coarse-grained sandstone.
    (*c*) Dark brown to reddish brown, water-worked and greatly modified sandy till from non-calcareous conglomerate and coarse-grained sandstone.
3. Grey-brown, non-calcareous stony glacial till loam derived mainly from granitic rocks.
4. Open and porous gravelly outwash material found mainly in eskers, kames and gravel beaches.
5. Alluvial, sandy material deposited in stratified layers along river channels to various depths.
6. Recently deposited, fine-grained river alluvium on low river flats.

Climate

The climate of the Woodstock area may be described in general terms as humid and temperate, but with reference to New Brunswick alone it is relatively dry and warm. Table 1 presents climatic statistics compiled from data gathered at the meteorological station at Woodstock and at other stations to the north (Plaster Rock, Grand Falls), and south of the map area (Harvey and Fredericton).

During the 21-year period the mean annual temperature at Woodstock was 40·4° F., and the mean monthly temperatures ranged from 11·3° F. in January to 67·4° in July. The average absolute minimum temperature was –26·6° F. in January, and the average absolute maximum was 89·8° F. in July. The temperatures at Harvey and Fredericton are essentially similar to those at Woodstock, although they are slightly lower in May, June, and July and slightly higher in January and February; the difference in either month being one or two degrees. Plaster Rock and Grand Falls, however, have a considerably colder climate throughout the year.

Columns T. and S. in Table 1 represent, respectively, the three-month season of June, July, and August—the season of optimum growing conditions—and the seven-month period from April to October, during which the soil is not frozen, and, therefore, subject to climatic influences. The mean temperatures for those periods are on approximately the same level at Woodstock, Harvey, and Fredericton, but decrease appreciably at Plaster Rock and Grand Falls.

While the temperatures in the Woodstock area are similar to those at Harvey and Fredericton and higher than those at Grand Falls and Plaster Rock, the total annual precipitation recorded at Woodstock is low (33·72 in.) in comparison with the data for Harvey and Fredericton (41·4 and 43·5 in.), but is on a par with the figures for the Plaster Rock and Grand Falls stations (33·52 and 36·63 in.). The two latter points receive a greater proportion of the precipitation in the form of snow than is the case at Woodstock.

The distribution of the precipitation in the Woodstock area is fairly uniform throughout the year. The average precipitation during each month of the growing season is more than 2·5 inches and less than 3·2 inches. However, much greater variations do occur in individual years and short drought periods may be encountered, which are sometimes severe enough to cause some reductions in yields.

TABLE 1—CLIMATIC DATA

—	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANN.	T. (2)	S. (3)
Mean temperatures (°F) (1)															
Woodstock, N.B. 134*	11·3	12·8	25·5	39·2	51·5	61·5	67·2	64·3	55·3	45·6	33·0	18·1	40·4	64·3	54·9
Harvey, N.B. 490*	14·1	14·9	25·0	37·9	50·2	60·5	65·7	64·5	55·9	45·3	32·9	18·7	40·5	63·6	54·3
Fredericton (Univ.) 164*	14·3	14·8	25·8	39·0	50·5	60·8	66·3	64·7	56·3	45·5	33·2	19·3	40·9	63·9	54·7
Grand Falls 498*	8·2	8·3	21·6	33·5	40·9	58·7	64·1	61·6	53·5	43·2	32·4	14·6	37·4	61·5	51·9
Plaster Rock 385*	5·4	5·8	19·5	31·4	43·3	54·9	60·3	58·6	50·9	40·6	27·2	11·3	34·1	57·9	48·6
Average precipitation (inches) (1) (including snowfall) (4)															
Woodstock	2·92	2·13	2·54	2·65	2·57	3·13	2·82	3·00	3·01	3·30	3·05	2·60	33·72	8·75	20·48
Harvey	3·94	3·01	2·61	2·86	2·99	3·39	3·14	3·39	3·87	5·33	3·42	3·49	41·4	9·92	24·97
Fredericton (Univ.)	3·54	2·68	3·12	3·34	3·15	3·54	3·64	3·97	3·78	4·96	3·36	3·51	43·5	11·15	26·38
Grand Falls	3·70	2·19	2·85	2·62	2·44	3·37	3·29	3·22	3·12	3·76	3·17	2·90	36·63	9·88	21·82
Plaster Rock	3·13	1·96	2·35	2·21	2·08	3·31	3·10	3·14	3·19	3·02	3·26	2·77	33·52	9·55	20·05
Average Snowfall (inches) (1)															
Woodstock	19·6	17·2	13·3	5·4	0·1	0	0	0	0	1·1	6·8	15·9	79·4	0	6·6
Fredericton (Univ.)	24·2	18·6	15·1	7·9	0·6	0	0	0	0	0·8	7·5	21·2	95·9	0	9·3
Grand Falls	28·7	18·8	17·3	7·5	0·2	0	0	0	0	2·5	9·4	22·6	107·0	0	19·6
Plaster Rock	23·5	17·4	16·3	6·6	0·1	0	0	0	0	2·8	9·6	20·0	96·3	0	19·1

Average Frost-Free Period (1)

Woodstock................May 24 to Sept. 19......118 days.
Harvey...................May 16 to Sept. 29......136 days.
Fredericton (Univ.)........May 18 to Oct. 6........141 days.
Grand Falls...............May 29 to Sept. 21......115 days.
Plaster Rock.............June 7 to Sept. 11....... 96 days.

NOTE.—*Elevation in feet above mean sea level.

(1) All figures are averaged over a number of years as follows: Woodstock 21 years; Harvey 15 years; Fredericton 15 years; Grand Falls 17 years; Plaster Rock 12 years.
(2) Three-month season June-Aug., inclusive.
(3) Seven-month season April-Oct., inclusive.
(4) 10 inches snow = 1 inch rain.

The divergencies in the climatic characteristics of the Woodstock district from those of other parts of the Province may be more easily understood if reference is made to the climatic regions into which New Brunswick may be divided (1). The Woodstock area is situated in a transition zone between the climatic region of northern New Brunswick and that of southern New Brunswick. The former is characterized by short, warm summers and long, cold, snowy winters. The mean temperature for the coldest month is 8° F., and for the warmest, 64° F. The average frost-free season is only about 90 days. In spite of a heavy annual snowfall (105 in.) the average annual precipitation is only 35 inches. The rainfall is heaviest in the three summer months amounting to 10·14 inches, but it is erratic, and droughts may occur.

Southern New Brunswick lies south of a line passing just north of Woodstock, Boiestown, Newcastle, and Tracadie. In this region mean temperatures are higher throughout the year (mean for July is 67° F., for January 13° F.,) and the frost-free season averages about 113 days. The mean annual precipitation (38 in.) is greater than in the north, the extra moisture coming mainly in the fall and winter.

Vegetation

The natural vegetation under the climatic conditions prevailing in the Woodstock area consists of forest trees; however, a large percentage of the land has been cleared of its original vegetation and is now under cultivation or in permanent pasture. Available statistics show that about 39 per cent of the total map area, or 55 per cent of the occupied land has been cleared. If the surveyed area is subdivided into two sections, it is found that in the more densely settled area lying west of the St. John river and north of the Meduxnekeag about 60 per cent of the total land, or 65·5 per cent of the occupied land, has been cleared, while in the remainder of the area only 31 per cent of all the land, or 49·5 per cent of the occupied land, has been brought under cultivation or is in permanent pasture. For purposes of comparison the following quotation from a previous report on the Soil Survey of the Fredericton-Gagetown Area is given: "Approximately 10·5 per cent of the total land area in the Fredericton-Gagetown area is cleared land, while the remainder is wooded. To the east of the Oromocto river, only about 8 per cent of the land is cleared, while west of here, about 13 per cent of the total area is cleared land." Figures for the whole province indicate that of its 17,734,400 acres of total land area 8·9 per cent is cleared, and of its 4,151,596 acres of occupied land 38 per cent is cleared.

The composition of the forest cover in this area varies considerably, and this variation is to some extent related to the parent materials and the drainage conditions of the soil. As a general rule the wooded, well drained land underlain by Silurian rocks has a cover of deciduous trees, mostly maple, yellow birch, and beech, whereas the areas with poor drainage on the same parent material grow spruce, fir, cedar, and some pine, hemlock and larch. Land with intermediate drainage often carries a mixed growth, in which spruce, white birch, and poplar predominate, with admixture of other hardwoods and softwoods. On very poorly drained and swampy soils and on peats and mucks stunted black spruce and cedar are the dominant trees with an undercover of sphagnum moss and sedges. The well drained areas underlain by the other rock formations carry more mixed and soft woods, with spruce predominating, while the poorly drained areas have vegetation similar to that on poorly drained locations on the Silurian formations.

As most of the cleared land is in well drained locations, it may be concluded that it was formerly covered by hardwoods and mixed woods. Dr. Abraham Gesner (1) wrote in 1847, with reference to the community of Wakefield: "The

timber on the uncleaned lands consists of spruce, fir, cedar, and pine, intermixed with birch and maple. The islands are covered with different varieties of hardwood and butternut", and further, "Great quantities of ashes remain upon new lands after the timber has been felled and burned". In 1865 Prof. H. Y. Hind (2) mentioned, "The presence of a rich forest of hardwood throughout the vast area covered by the Upper and Lower Silurian rocks".

In poorly farmed and "run-down" hay meadows and pastures, weeds soon form the dominant vegetation; the most prevalent weeds are red sorrel, orange hawkweed, poverty grass, ox-eye daisy, and couch grass. Abandoned land and sparsely grazed pastures in a comparatively short time revert to the natural vegetation, bushes and forest trees. Sparsely grazed pastures usually grow up in softwoods, while ungrazed land has a greater tendency to revert to mixed hardwoods.

Development and Organization

The first extensive settlements in what is now Carleton county were formed after the war of 1812, when the New Brunswick government granted lands there to disbanded soldiers, partly for the purpose of protecting the main route of travel to Quebec. The settlers were of Irish, Scotch, and English descent, and subsequent settlements were formed chiefly by people of the same nationalities. A good many of the later settlers were United Empire Loyalists.

The first lands to be granted and cleared were between the Meduxnekeag and the Presquile, but gradually people settled both north and south of those rivers. In 1803, the township of Woodstock was reported (2) to have a population of 380 people, and that of Northampton 328. In 1824 the population was distributed as follows: Parish of Woodstock, 816; Northampton, 568; Wakefield, 1,011; Kent, 2,285; making a total of 4,690. In 1834 these figures had risen as follows: Parish of Woodstock, 1,876; Northampton, 900; Wakefield, 1,713; Kent, 3,880; making a total of 7,929. All figures just given were submitted by clergymen. According to the census of 1834 Carleton county had then a population of 9,493, covered 4,400 square miles, and contained 148,000 acres surveyed and open for settlement. The census of 1840 gives the population as 13,330. Later figures are found in the following census table: —

TABLE 2—POPULATION OF CARLETON COUNTY 1871-1931

—	1871	1881	1891	1901	1911	1921	1931
Urban	2,282	2,487	3,288	3,644	3,856	4,209	4,166
Rural	17,656	20,878	19,241	17,977	17,590	16,841	16,630
Total	19,938	23,365	22,529	21,621	21,446	21,050	20,796

The rural population reached its peak in 1881 and shows a slight decline for each of the following decades, while the urban population increased up to 1921.

Carleton was originally part of York county, but was created a separate county in 1832. In April 1852 the county received its charter of incorporation, the first in the province to do so, and Woodstock was incorporated as a town in 1856. The railways were constructed about the middle of the century.

Woodstock, whose population in 1931 was 3,259 persons, a decline of 121 from the figure for 1921, is the principal trading centre of the district as well as the Carleton county seat. Originally the town was an important lumbering centre, but since the decline of that industry it has become engaged mainly in providing facilities for its agricultural upland. A woollen mill does custom work for the farmers, and a local creamery with about 500 patrons serves the community.

Hartland is located about nine miles farther up on the St. John river and had in 1931 a population of 907 persons. Chief industry of the town is potato starch manufacturing. A seed cleaning plant is also functioning at Hartland.

The surveyed area, particularly west of the St. John river is well served by roads and railways. The Canadian National Railways has a branch line from Fredericton to Woodstock and Centreville, and the Canadian Pacific has a line from McAdam to Debec, where one branch connects with Houlton, Me., and another goes through Woodstock, crosses to the east side of the river, passes through Hartland and continues north to Edmundston and the province of Quebec.

The trunk highway traversing the province from Nova Scotia to Quebec by way of Moncton, Saint John, Fredericton and Edmundston and designated as Route 2, follows the St. John river along its course through the Woodstock district, crossing from the west to the east side of the river at Hartland by way of the longest covered bridge in the world (1282). Another hard-surfaced highway leads from Woodstock to Houlton, Me., a distance of only 14 miles. A network of secondary roads renders almost every settled part of the area easy of access by automobile. The following table, prepared from the census of 1931, is of interest in this connection:—

TABLE 3—DISTANCE OF FARMS FROM NEAREST MARKET TOWN AND RAILWAY STATION (CARLETON COUNTY)

Distance to market town	No. of farms	Distance to R.R. Station	No. of farms
Under 5 miles	1,101	Under 5 miles	1,526
5 to 9 miles	1,024	5 to 9 miles	803
10 to 14 miles	377	10 to 14 miles	216
15 to 24 miles	63	15 to 25 miles	15
25 miles and over	.....	25 miles and over	.....
Not reporting	5	Not reporting	10

Of 2,569 farmers reporting in 1931, 97 were located on hard-surfaced macadamized roads, 2,102 on gravel roads, 222 on improved dirt roads, and 148 on unimproved dirt roads. Since that time, the mileage of hard-surfaced roads has been very greatly increased.

Facilities on farms in Carleton county were reported as follows in the census of 1931:—

	No. of farms
Water piped in the home (kitchen or bathroom)	484
Telephone	1,070
Radio	280
Electric light or gas	194

Census figures show that in 1931 the percentage of farms in Carleton county equipped with the facilities listed above was greater than the average for the province. In addition, the number of farm tractors in the county was 93, being exactly one-third of the total reported on all farms in the province. Approximately 50 per cent of all farmers in Carleton county reported possession of automobiles, and 22 per cent had threshing machines.

Agricultural History and Statistics

The agricultural history of Carleton county is less than 150 years old. Some interesting information on its course is to be found in various reports and texts (3, 4, 5) written during the last century. The province was then young,

and its natural resources in the form of soils, forests, and minerals, were largely untapped. Lumbering was the first industry to develop but the authorities, realizing that the permanent welfare of the province would be intimately tied up with agriculture, were chiefly concerned about settling farmers on the land In Carleton county farming was at first considered merely an adjunct to the more profitable lumbering operations, but as the timber disappeared, agriculture came into its own.

It was generally agreed that the soils in Carleton county were well suited for farming purposes. Good crops of wheat, corn, oats, rye, flax, hemp, and vegetables were reported as early as in 1803. In 1847 Dr. Abraham Gesner, Provincial Geologist (3), said of the Woodstock-Jacksontown-Richmond area, "The soil in this quarter is a calcareous loam, interspersed with argillaceous and siliceous knolls and hollows. It produces abundant crops of wheat, rye, barley, oats, flax, Indian corn, potatoes, turnips, and all kinds of garden vegetables. It is also well adapted to horticulture; but fruit trees have scarcely yet been cultivated".

Good soils were in many instances abused through the land clearing practices which were generally followed in Canada in the early days of settlement, but which in the light of more modern knowledge are extremely harmful to the soil. There is some evidence (3, 4, 5) to show that those practices were followed in Carleton county as well as elsewhere in New Brunswick. A piece of land was first marked out in the forest, and then all tree growth was cut down and burned on a dry, warm day. The ashes were then spread and the land seeded. During the first ten years, no ploughing was done, no manuring needed on the virgin soil. Many settlers had no idea of the rotation of crops, or the art of keeping the land in proper condition by manuring and good management. It was quite common to take one crop of grain after another, year after year, from the same ground, until the soil was worn out, or to mow the same field annually, sometimes for more than 20 years, or until the hay would not pay for mowing. (4)

The government became concerned and engaged Dr. J. F. W. Johnston, Professor in agricultural chemistry at Cambridge University to make an agricultural survey of the province. Dr. Johnston found that the unsatisfactory state of farming was due to a number of causes, among which were: unsatisfactory cultural treatments of the soil, waste of manure, lack of rotations, and the growing of too many successive crops of the same kind. He suggested, among other things, the clearing of land without destructive burning, greater saving and better use of manure, and the use of lime, chemical fertilizers, and of suitable rotation.

As already stated lumbering was the principal industry in Carleton county in its early days, but through the latter half of the last century people became more conscious of the possibilities inherent in their soils. With the formation of the Carleton County Agricultural Society in 1832, the incorporation of Carleton county in 1852, of the town of Woodstock in 1856, and the construction of railways through the district, also about the middle of the century, the development of the county was facilitated, and it may be assumed that agricultural progress was steady, until, only a few decades ago, specialization in potato growing (6) became an economic factor of great importance.

The trend of the agricultural development in Carleton county, in which the larger part of the surveyed area is situated, during the past 70 years is shown in table 4. This table shows that the area of improved land increased up to 1911 when it reached its maximum, and it has decreased somewhat since that time. Some of the land has been abandoned and reverted to trees. The largest number of farms was reported in 1880, but since that time the number has

decreased by almost one-quarter. This decrease in the number of farms coincides with a considerable increase in the size of the farms.

Almost half of all the improved land was in hay in 1911, but in later years the total acreage as well as the percentage of land in hay has decreased somewhat. The acreage of oats did not change appreciably from 1910 to 1930, but the acreage of potatoes was more than doubled from 1911 to 1921, and the maximum acreage was recorded in 1931. That was the period during which many farmers began to specialize in potato growing and when the demand and the prices for potatoes were good. Since 1931 the acreages of most crops, especially potatoes, have dropped considerably.

TABLE 4—THE NUMBER AND SIZE OF FARMS AND THE ACREAGES AND YIELDS OF THE THREE MAIN CROPS—HAY, OATS, AND POTATOES—IN CARLETON COUNTY FROM 1870 TO 1931*

Year	No. of farms	Average Size of farms (acres)	Improved land (acres)	Hay (acres)	Oats (acres)	Potatoes (acres)	Yield per acre		
							Hay (tons)	Oats (bu.)	Potatoes (bu.)
1870–71.........	2,689	123·4	118,671	32,035	....	3,421	·92	....	155·5
1880–81.........	3,280	118·4	150,771	44,599	....	4,212	·95	....	157·3
1910–11.........	3,100	140·1	228,516	115,178	45,484	5,741	·86	31·7	154·7
1920–21.........	2,881	144·6	224,146	93,219	41,995	14,424	·91	30·6	140·9
1930–31.........	2,570	158·0	213,040	99,901	45,874	14,632	·67	30·7	244·9

*Figures compiled from the Census of Agriculture (1871–1931).

No average yields for long-term periods are available for the main crops in the surveyed area. However, average yields for the individual census years 1871-1931 are recorded in table 4. It is interesting to note that the average yields of hay during the first four census years were remarkably uniform. In 1930 the hay yield was considerably lower averaging only 0·67 ton per acre. This low yield is partially due to a poor hay year and partly due to the decreased fertility of the hay land as a result of the intensive potato growing and the application of practically all the manure and fertilizers to the potato crop. The average hay yields in Carleton county were 15 per cent lower than the average yields during the corresponding years in the province as a whole. The average oat yields did not vary appreciably in the three recorded census years and they were 10 per cent higher than the average yields during the same years in the entire province. The average potato yield in 1930 was very much higher than in the other years reported. This may be partly due to more intensive potato farming, which involves the use of large quantities of commercial fertilizers. The average potato yield in Carleton county during the five census years was 24 per cent higher than the average yield of the entire province in the same years.

A somewhat more detailed account of the disposition of the land in the surveyed area is given in table 5, which is based on the census returns of 1931.

This table shows that about 70 per cent of the entire area of 500,000 acres is occupied land, and that about half of the occupied land has been improved. However, it is also seen that the distribution of the occupied and improved land is not uniform throughout the area. In district B, which consists of the parishes of Wakefield, Wilmot, Simonds, and part of Wicklow, in which practically all the soils have been derived from Silurian parent materials, 90 per cent of the

TABLE 5—LAND UTILIZATION AND DISTRIBUTION OF CROPS*

Areas	No. of Farms	Total Area	Area of Occupied Land		Utilization of Occupied Land						Distribution of Crops					
					Improved			Unimproved								
					Total (3)	Under Crops	Pasture	Total	Woods	Natural Pasture	Oats	Wheat	Hay	Pota-toes	Other Field Crops	Gardens and Small Fruit
	No.	acres	acres	% of corresponding total	acres	acres	acres	acres	acres	acres	acres	acres	acres	acres	acres	acres
Entire map Area— Total	2,148	500,022	350,022	70·0	172,917	140,937	28,255	177,105	157,173	19,932	37,289	1,210	82,697	11,539	6,981	1,221
Per Farm			163·0		80·5	65·6	13·1	82·5	73·4	9·3	17·4	0·5	38·5	5·3	3·2	0·5
District(1) "B"— Total	795	134,340	121,840	90·7	74,793	62,370	10,615	47,047	41,982	5,065	17,423	801	34,225	6,311	3,262	348
Per Farm			153·3		94·1	78·5	13·3	59·2	52·8	6·4	21·9	1·0	43·1	7·9	4·1	0·4
District(2) "C"— Total	1,353	365,682	228,182	62·4	98,124	78,567	17,640	130,088	115,191	14,867	19,866	40·9	48,472	5,228	3,719	873
Per Farm			168·6		72·5	58·1	13·0	96·1	85·1	11·0	14·7	0·3	35·8	3·9	2·7	0·6

NOTES.—* Figures compiled from the 1931 census of Agriculture.
(1) District B comprises that part of the map area which lies north of Meduxnekeag and west of the St. John River and includes the parishes of Wakefield, Wilmot, Simonds, and one half of Wicklow.
(2) District C comprises the remaining larger part of the map area.
(3) Includes land in crops and pasture and land occupied by buildings and farm roads.

entire land area is occupied, and more than 60 per cent of this has been improved. On the other hand, in district C, or the remainder of the area, in which a large proportion of the soils have been derived from other than Silurian parent materials, only 62 per cent of the land has been occupied, and 43 per cent of this has been improved. The size of the farms is greater in district C than in B by about 15 acres, but the area of improved and of cropped land per farm is considerably greater in district B than in C.

More than half of the cropped land in the surveyed area is in hay, but the percentage of hay land in relation to the cropped acreage is smaller in B than in C, while the acreage of hay per farm is greater in B than in C. Oats are the main grain crop, occupying over one-quarter of the cropped land; the percentage of the oat acreage in relation to the area of crop land is higher in district B than in C. About 10 per cent of all the cropped land in district B is planted to potatoes, while in district C the percentage of land devoted to potatoes is much smaller. Most of the potatoes in the latter district are grown in the western sections of Peel and Kent parishes, where the soils have been derived mainly from Silurian materials and are very similar to those of district B.

The data in table 5 reflect the different types of farming practised in the Woodstock area. In district B and in the western sections of district C, more specialized, and, to some extent, more "mechanized" types of farming are practised. Potatoes and grain are the most important crops. The rotations are generally of fairly short duration and in many cases consist of potatoes, grain, hay, hay. In the remaining section of the area, the rotations are usually longer and more mixed farming is practised. More cattle and sheep are kept per unit area of improved land in district C than in B. In the latter section, however, more swine are kept per unit area of improved land, which practice fits in with the specialization in potato growing.

TABLE 6—NUMBERS OF LIVE STOCK KEPT IN THE SURVEYED AREA IN 1931

Areas	Horses	Cattle		Sheep	Swine
		Milk Cows	Others		
Entire Map Area—Total	5,601	7,245	9,292	14,158	7,919
Per Farm	2·60	3·37	4·32	6·59	3·68
District "B"(1)—Total	2,310	2,815	3,430	4,375	3,506
Per Farm	2·91	3·54	4·31	5·50	4·41
District "C"(2)	3,291	4,430	5,862	9,783	4,413
Per Farm	2·43	3·27	4·33	7·30	3·26

NOTE.—(1) District "B" comprises that part of the map area which lies north of the Meduxnekeag and west of the St. John rivers and includes the parishes of Wakefield, Wilmot, Simonds, and one-half of Wicklow.

(2) District "C" comprises the remaining larger part of the map area.

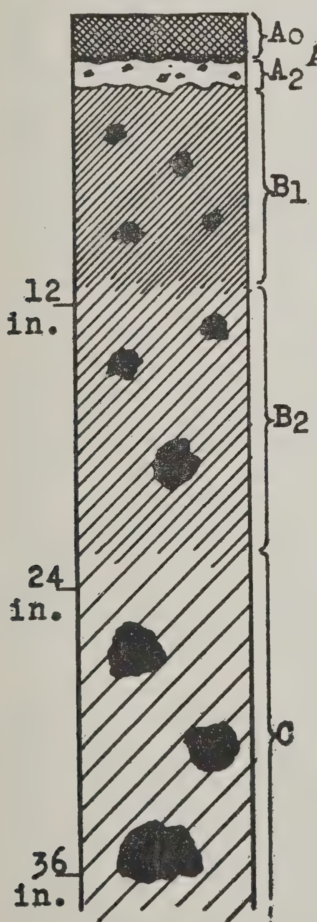
SOILS

A general discussion of the development of the soils in the Woodstock area, together with the definition of some soil terms and a description of soil survey methods will be of value in giving a better understanding and a greater appreciation of the description and discussion of the soils, which are given in this report.

Soil Development

The soil is a complex body which has been developed over a long period of time as a result of the weathering action of climate, vegetation, and micro-organisms on the mineral rock fragments. A soil, therefore, not only consists of mineral materials in various stages of disintegration, but also contains living plant roots, dead plant remains in various stages of decomposition and many kinds of bacteria, fungi, earthworms, etc., all of which play an important part in the soil and determine its capacity for producing crops.

The climate, because of its pronounced effect on the vegetation as well as on the soil is instrumental in the development of some of the major soil characteristics; consequently soils formed under different climatic conditions



A_0 Forest litter, largely undecomposed.

A_1 Black, well-decomposed humus, often mixed with mineral soil, when present; usually absent.

A_2 Ash grey; leached horizon.

B_1 Reddish brown to orange yellow layer.

B_2 Brown to reddish brown or yellowish brown layer, slightly compacted.

C Soil parent material, largely unchanged by soil forming process.

Fig. 1.—Diagram representing an average profile of a normal, well-drained soil in the Woodstock district.

vary greatly. Under climatic conditions, such as have existed in the Woodstock area and in most parts of New Brunswick for centuries, the normal tendency is toward the formation of acid and leached soils. Such soils are known to soil specialists throughout the world as "podsol" soils, and they are frequently referred to by that name in this report. When a vertical cross-section, called a soil profile, of an undisturbed podsol soil in the Woodstock area is examined, the following striking colour scheme is evident (see Fig. 1). The top few inches usually consist of dark brown or black, partly decayed organic matter. The upper, coarse and poorly decomposed part of this layer is called the A_0 horizon, while the lower, better decomposed part, which is usually mixed with the mineral soil, is referred to as the A_1 horizon. The latter is often absent. Below the dark organic layer is a whiteish-grey, ash-like layer, the A_2 horizon, from ½ to 6 inches or more in thickness. This is followed by a reddish or rusty brown layer, the B horizon, which may vary in thickness from 6 to 24 inches or more. The colour of the B horizon often fades with depth. The subsoil consists of unaltered or slightly weathered mineral material, and it is usually called the C horizon or the parent material of the soil. The colour of this horizon depends largely on the nature of the parent mineral material, which in the Woodstock area varies from grey to reddish brown and red.

During the formation of a soil profile such as the one described above, the forest litter under cool and moist climatic conditions decomposes slowly and accumulates on the surface. The decomposition products contain organic acids, which impart to the soil an acid reaction and cause the soluble bases, such as lime, potash and magnesia, and to a lesser extent iron and alumina (the latter two together are usually referred to as sesquioxides) to be leached from the upper horizons. Due to these processes the A_2 horizon assumes its leached, ash-like appearance. It contains a relatively high percentage of silica, while the iron and alumina, which have been removed from the A_2 horizon, become concentrated in the B horizon and impart to it the reddish brown colour.

The various horizons of podsol soils possess certain typical characteristics, which to a large extent determine the fertility and productivity of these soils. A clear conception of these inherent characteristics is often of great value in the management and utilization of the soils. Practically all the organic matter is concentrated in the A_0 horizon, and it can absorb considerable plant food, when the latter is applied in the form of manure and fertilizers, but this layer is very acid, and it requires lime to neutralize the acidity. The A_2 horizon is also very acid, but it is very poor in organic matter and plant food, and it usually lacks the capacity to absorb large quantities of nutrient elements, when they are artificially applied. The B horizons are as a rule less acid, and they usually contain somewhat more plant food than the A_2 horizon above them. The accumulations of iron and alumina in these layers often cause a compact and unfavourable physical condition. Large amounts of the soluble plant nutritients have been washed out of the soil by the percolating moisture and carried away by drainage. As a result the natural fertility of these leached podsolic soils is relatively low.

The Woodstock area lies in a climatic zone where the formation of podsol soils predominates, but due to the influence of local factors, such as the nature of the parent material, the topography, drainage conditions, vegetation, and the activity of soil micro-organisms, the extent of leaching of the different soils varies considerably. The soils formed on well drained till which has been derived largely from Silurian shales and slates show comparatively little leaching. The grey A_2 horizon is thin, and the reddish-brown colour of the B horizon is not very intense. This condition is partly due to the fact that the unweathered shale fragments contain some free lime, which is liberated on further weathering of the shale and partially neutralizes the organic acids. Also, the dominant

vegetation on these soils was originally hardwoods, the foliage of which is relatively high in lime and other minerals. The deciduous foliage decomposes quite readily on well-drained positions, where micro-organisms work efficiently. On the other hand, the soils which have formed from parent materials that lack free lime and are low in other bases, as for instance many sandy and gravelly, water-deposited materials and the till derived from carboniferous sandstones, have been quite strongly leached as indicated by a pronounced grey A_2 horizon and a well developed reddish B layer. On these soils, coniferous trees are more abundant, and their foliage is low in lime and is more resistant to decomposition. The soils which have formed under the deciduous vegetation on calcareous parent materials are usually more fertile than those developed under the coniferous vegetation on non-calcareous deposits.

Drainage has also a great effect on the development of the soil and the resultant soil characteristics. The well-drained soils in the Woodstock district all exhibit some degree of leaching or podsolization. Under conditions of poor drainage the ground water table is often high, thus limiting the penetration of air through the soil and restricting the bacterial life in the soil. This condition results in the accumulation of organic matter at the surface, due to the lack of microbiological activity. The subsoil also becomes discoloured and may show yellow, rusty, black, or bluish mottling due to the lack of oxidation of chemical substances in the absence of air. In very poorly drained soils the motted discoloration appears close to the surface, while in well-drained soils such discoloration never occurs. In the Woodstock area poorly drained soils which receive drainage waters charged with lime and other bases seldom show marked signs of leaching or podsolization. On the other hand, those poorly drained soils which receive drainage waters deficient in lime and other bases are usually more severely leached than the adjacent well drained soils. Under extremely moist conditions, the organic matter often accumulates very rapidly and gives rise to the formation of peat and muck soils.

Soil Survey Methods

The soil survey of the Woodstock district was conducted so as to differentiate and describe all the soils in the area and to show their location and extent on a map.

The differentiation of the soils was based on a knowledge of the mode of deposition and the geological nature of the parent material, on drainage conditions, reaction, morphology, i.e. texture, colour, depth and number of horizons, structure, etc., and on the degree of stoniness. In order to ascertain those characteristics test holes were dug at frequent intervals. The soil boundaries were determined from the information gained at the test holes and from observations of the physical features of the land. The degree of slope of the land was estimated and noted on the map.

During the survey, all passable roads were traversed by car and frequent foot traverses along compass lines were made across the fields of the farms. In this manner, all the cleared land was examined; the distance between the different traverses varied from $\frac{1}{3}$ to 1 mile depending on the degree of uniformity of the soil and on the topography and the lay of the land. In the heavily wooded areas, especially in the eastern and southeastern sections of the map area, where the roads are far apart, foot traverses were made along bush trails. The distances between traverses were considerably greater than in the cleared areas and consequently the soil boundaries in the heavily wooded sections were mapped in less detail and with less accuracy than in the largely cleared and cultivated parts.

The distribution of the soils was shown on field sheets by plotting the soil boundaries as accurately as possible in relation to geographical features, such as

roads, railroads, rivers, etc., which are also given on the sails map. The field work was carried out without the aid of accurate topographic base maps, and frequent additions and corrections had to be made on the available maps as the work proceeded and circumstances permitted. The absolute reliability of the planimetric detail, especially in the wooded country, can, therefore, not be guaranteed.

After a given area had been surveyed, representative samples were taken of the different horizons of each soil type. Whenever possible, the samples were taken from uncultivated, undisturbed, forested land. In addition, surface samples to plough depth were collected from cultivated land, preferably from a hay field or pasture which had received no lime, manure, or fertilizer for a number of years, in order to avoid misleading analytical results.

The samples were air-dried as soon as possible after they had been collected and were then ground and passed through a 20-mesh sieve for subsequent physical and chemical analyses. Soil textures were determined by the Bouyoucos method according to the procedure outlined in Soil Science, Vol. 38, 1934. The soil reaction was estimated in the field by the use of indicators (brom-cresol-green, chlor-phenol-red, and brom-thymol-blue), and determined more accurately in the laboratory by means of a Beckman (glass electrode) pH meter. Standard A.O.A.C. methods of procedure were followed in the determination of individual constituents. For the analyses requiring fusion methods small portions of the samples were ground to pass a 100-mesh sieve.

Classification of the Soils

Soils may be classified and grouped in various ways for different purposes. In this report the soils have been classified according to those inherent characteristics which have resulted from the influence of the main soil forming factors, which have been discussed earlier. This classification shows the relationship between the different soils, and it may serve as a basis for scientific study of these soils and of their characteristics. All the soils which have been mapped in the Woodstock area are listed in the following scheme:—

Scheme of Classification

Podsol Zone (soils with grey, leached A_2 horizon dominate; local soils which lack this layer are specially indicated as intrazonal or azonal)

A. Soils Developed on Glacial Till.

I. Caribou-Washburn and Carleton-Washburn Associations

Soils developed on slightly modified grey loamy till derived mainly from underlying dark grey shale and slate and, to a lesser extent, from micaceous and schistose sandstone (Silurian and pre-Silurian formations).

(*a*) Well drained soils

1. Caribou series.—Soft (Silurian) shale and slate fragments common in profile and dominate over (pre-Silurian) sandstone fragments.
   (1) Caribou heavy loam
   (2) Caribou light loam
   (3) Caribou silty loam
   (4) Caribou shaly loam.
2. Carleton series.—Sandstone fragments (pre-Silurian) common in profile and dominate over soft (Silurian) shale and slate fragments.
   (1) Carleton clay loam to clay
   (2) Carleton loam.

(*b*) Ill drained soils

3. Washburn series (intrazonal—not podsolized)

(1) Washburn clay

(2) Washburn clay loam

Swampy phase of clay and clay loam.

II. Kingsclear-Nackawic Association

Soils developed on reddish brown to red till, derived mainly from red, slightly calcareous, fine grained sandstone and conglomerate (Carboniferous formation)

(*a*) Well drained soils

4. Kingsclear series

(1) Kingsclear clay loam

(*b*) Ill drained soils

5. Nackawic series (intrazonal—not podsolized)

(1) Nackawic clay loam

III. Parry-Midway Association

Soils developed on reddish brown till, derived mainly from reddish brown, strongly weathered, coarse grained Carboniferous sandstone and conglomerate.

(*a*) Well drained soils

6. Parry series

(1) Parry sandy loam

(*b*) Ill drained soils

7. Midway series

(1) Midway sandy loam

IV. Becaguimec-Snyder Association

Soils developed from reddish brown, modified, sandy loam till, derived largely from reddish brown Carboniferous sandstone and conglomerate.

(*a*) Well drained soils

8. Becaguimec series

(1) Becaguimec sandy loam

(*b*) Ill drained soils

9. Snyder series

(1) Snyder sandy loam

V. Pinder Association

Soils developed on greyish loamy till, derived mainly from granitic rocks (Devonian age). In some places the till is thin and the soil has developed partly from crumbling residual bed-rock.

(*a*) Well drained soils

10. Pinder series

(1) Pinder loam

B. Soils developed on stratified, water-deposited parent materials.

I. Gagetown Association

Soils developed on gravelly outwash, kames, and eskers; gravelly materials of mixed geological origin.

(*a*) Well drained soils

11. Gagetown series

(1) Gagetown gravelly loam
(2) Gagetown sandy gravelly loam

II. Riverbank-Oromocto Association

Soils developed on sandy deposits along river terraces; materials of mixed origin.

(*a*) Well drained soils

12. Riverbank series

(1) Riverbank sandy loam
(2) Riverbank fine sandy loam

(*b*) Ill drained soils

13. Oromocto series

(1) Oromocto sandy loam
(2) Oromocto fine sandy loam

III. Interval Association

Immature soils on recently deposited bottom land (Azonal soils—not podsolized).

(a) well drained soils (subject to periodic flooding)

14. Interval series.

(1) Interval silty loam
(2) Interval very fine sandy loam

(*b*) Ill drained soils.

Poorly drained soils of the Interval association have not been given a separate name. They are referred to as ill drained associates and are indicated on the map thus: Isil-i

C. Organic soils, developed on dead plant remains, which vary in depth from 12 inches to 4 feet or more.

I. Peat soils; plant remains are fibrous and poorly decomposed (consist largely of sphagum moss).

II. Muck soils; surface soil to depth of 12 inches or more is dark brown or black and fairly well decomposed. (Organic materials consist largely of sedges and woody remains.)

D. Rough and stony land. Undifferentiated soils on rugged, non-agricultural land.

Some of the soils have been further subdivided into soil phases on the basis of certain physical features, such as stoniness, topography, etc., which often have an important bearing on the utilization of the land. The various phases of the different soils are not listed in the above classification scheme but they are shown on the soils map as follows:—

st—Stony phase; soil contains more stones than the normal soil type as described, stones interfere seriously with cultivation.

v—Rock outcrops; shallow soils with numerous outcrops of bed-rock are indicated.

g—Gravelly phase; the soil contains more gravel, usually in the form of lenses or pockets, than is ordinarily found in the soil under consideration.

Topographic Phases

A—Level to gently undulating (slopes not exceeding $2\frac{1}{2}$ per cent).

B—Undulating to gently rolling (dominant slopes vary from $2\frac{1}{2}$ to $7\frac{1}{2}$ per cent).

C—Rolling to strongly rolling (dominant slopes vary from $7\frac{1}{2}$ to 15 per cent).

D—Strongly rolling to hilly (dominant slopes vary from 15 to 25 per cent).

E—Hilly to mountainous (dominant slopes more than 25 per cent).

Discussion of Classification Scheme

The outlined classification scheme shows that the Woodstock area lies in the podsol zone, i.e., a climatic and vegetative zone in which the soils in time develop into acid, leached soils with the characteristic white A_2, and a reddish brown B horizon as described earlier. Those soils which, through the influence of local factors, have been prevented from acquiring the characteristics of the typically leached podsol soils have been indicated. These are designated as "intrazonal" soils, i.e., soil in which zonal characteristics have not developed due to the influence of drainage waters charged with lime or other bases, as in the case of the Washburn and Nackawic series, or "azonal" soils, i.e., soils without any definite profile development due to the comparatively short period of time since the soil material was deposited, as in the case of the Interval soils.

The soils have further been classified according to the parent materials from which they have developed. The most striking differences between the parent materials of the soil in the Woodstock area are due to their mode of deposition. The glacial till, on which the largest proportion of the soils in this area have developed, consists of unsorted material, varying in texture from sandy loam to clay loam, which was deposited by glacial ice. It usually contains stone fragments and boulders, which in some cases are very numerous. The topography varies from gently undulating to hilly. The water-deposited parent materials are usually better sorted, and they vary in texture from silt loams to gravels. They have smoother topography, and stones and boulders are scarce or absent. The organic soils have developed from accumulated dead vegetative matter, such as moss, sedges, grasses and trees.

Both the till and the water-deposited soils were further subdivided according to the nature of their parent materials. Thus, in the Woodstock area, at least six different tills were encountered, which are those derived from:—

(1) Calcareous shales and slates of the Silurian; (2) Slightly calcareous shales and schistose sandstones of the pre-Silurian; (3) Fine-grained, calcareous sandstones, shales and conglomerates of the Carboniferous; (4) Coarse-grained, non-calcareous sandstones and sandstone conglomerates of the Carboniferous; (5) Reworked and slightly sorted till of Carboniferous sandstone origin; and (6) Granites and gneisses of the Devonian. The water-deposited materials were divided into three kinds:

(1) Coarse poorly sorted gravel on outwash fans, kames and eskers; (2) Sandy well-sorted deposits over gravel, till or bed-rock; and (3) Recently deposited alluvial silts and very fine sands. Each of the different parent materials has imparted certain characteristics to the soils which have developed on it. The group of soils occurring on any one of the parent materials is referred to as a "soil association".

The greatest variations between the different soils of an association in the Woodstock area are due to drainage conditions which have brought about differences in the amount of organic matter present in the soil and in many cases have affected the appearance of the entire soil profile. The individual members of a soil association are referred to as "soil series". The soils of a series vary but little; the appearance of their profiles is fairly constant in respect to the number and arrangement of horizons present, in respect to colour, structure, compactness and in their general fertility. The series of an association form a natural land pattern which is often closely related to topographic features. A series usually is named after the locality where it was first found, or where it occurs most extensively. The name may be that of a town, river, or it may be of some other local significance. In most cases, two series have been mapped in a soil association, but occasionally (Gagetown Association) only one series was established. Under some conditions, especially in a more detailed survey, it may be necessary to establish more than two series in an association.

In this survey an area which has been mapped as a definite soil series, say Riverbank, often contains small areas, which could not be mapped on the present scale, of the poorly drained counterpart, in this case, the Oromocto series. In other instances, it was impossible or impractical (as in the heavily wooded areas) to separate and map all the individual soil series, although the extent and the nature of the parent materials could easily be indicated. Such areas have been mapped as associations, and the approximate percentage of each series in the area has been estimated without indicating their respective boundary lines on the map.

Although a soil is quite narrowly defined and does not deviate from a standard pattern to any appreciable degree, small differences in texture do occur, especially in the top soil. A series may, therefore, be divided into soil types according to the textural classes into which the top soil may fall. As a rule only two or three types are found within any one series, and the differences in texture between the types are not great. The soil type is the basic unit in the classification scheme, and in most cases it has also been employed as the mapping unit. It is named by adding the proper textural class description to the name of the series to which it belongs.

A soil type or a series is often modified by accidental properties, such as stoniness, slope, and accelerated erosion, which may prove to be determining factors in the proper utilization and management of the soils concerned. Such modifications are called soil phases; they are used as mapping units, but are not listed in the classification scheme, which is built solely on inherent soil characteristics. Thus, if it is possible to delineate an area in which a given soil type is more stony or on steeper land than usual, the soil within that area is mapped as a stony or a sloping phase, respectively, of the type concerned, and the degree of stoniness and/or slope is indicated by symbols. Some soil types or series may only be found on one particular kind of topography, while others may occur on a wide topographic range. Similarly some soil series are always stone free, while others may vary greatly in degree of stoniness.

Description and Discussion of Soils

Soils Developed on Glacial Till

The largest proportion of the soils in the Woodstock area (86·5 per cent) are till soils. They differ collectively from other soils in the district by having developed from materials which have been moved and deposited by glaciers as a heterogeneous mass. The texture of the till in the map area is dominantly loamy, although some clay loams and some sandy loams also occur. The till soils are locally referred to as "Upland soils", and they are easily recognized by the varying amounts of small stones and boulders, which are invariably present, and by the topography, which varies from undulating to hilly.

The chemical and mineralogical nature of the till, however, varies considerably depending on the source of the dominating geological material. In the Woodstock area the till is in most cases closely related to the underlying geological formations.

1. Soils developed on grey loamy till which has been derived mainly from underlying calcareous dark grey and occasionally bluish and greenish shale and slate and from micaceous and schistose sandstone of Silurian and pre-Silurian formations.

The Caribou-Washburn and Carleton-Washburn Associations

The soils of these associations occupy approximately 371,000 acres, or about 75 per cent of the entire map area. In the northwestern part of the map area (designated as area "B" in table 5), the Caribou and the Washburn series form a natural land pattern, in which the Caribou soils occupy the well drained gently sloping land and the hillsides, and the Washburn soils are found in the poorly drained, depressional areas and hollows. The parent material of these soils has been derived mainly from calcareous shales and slates of Silurian age. Toward the south and east (in the sections of the area designated as "C" in table 5), the Carleton and the Washburn series form a natural land pattern, the Carleton soils occurring on the well-drained land and the Washburn soils in the poorly drained positions. These soils have developed on till which has been derived, mainly from pre-Silurian sandstones and to a lesser extent, from calcareous Silurian shales and slates. Although the difference between the two parent materials developed from the Silurian and pre-Silurian, respectively, is not very great, it has been significant enough to cause the formation of two different well drained soils, the Caribou and the Carleton series. However, the poorly drained soils on both parent materials are so much alike that for all practical purposes, as well as for pedological reasons, they can be considered as one series, the Washburn series. The effect of the poor drainage on the development of the soil in this case has been so pronounced as to overshadow the natural tendency of different parent materials to form different soils. For this reason it has seemed desirable to discuss the two soil associations together.

(*a*) *Well Drained Soils*

The two well drained members of these associations, the Caribou and the Carleton series, occupy approximately 231,000 acres or about 46 per cent of the entire area. As already mentioned, they have formed from somewhat different parent materials. Numerous shale fragments are found throughout the profiles of the Caribou series, while in the profiles of the Carleton soils, shale fragments are comparatively scarce, and sandstone fragments of various sizes are more common. Both soils have a greyish-brown to brown surface soil when cultivated, while under wooded virgin conditions both have a grey leached A_2 horizon, but the latter is somewhat deeper and better developed in the Carleton series. The subsurface layer (B horizon) is slightly more developed in the Carleton than in

the Caribou series, and has a somewhat deeper brown colour. The structure of both of these soils varies from fine granular to coarse granular, but the Caribou soils are usually more mellow and friable than the Carleton soils. The subsoil (C horizon) in both soils is fairly porous, but the Carleton subsoils are usually somewhat more compact than those of the Caribou soils. Shale fragments effervescing with dilute acid are frequently found in the Caribou soils, while very few fragments effervesce with acid in the subsoils of the Carleton series. The range in texture is somewhat wider in the Carleton than in the Caribou series. While a typical Caribou soil can be easily distinguished from a typical Carleton soil, near the lines where the two soils join, and where one parent material grades into the other, it is often difficult to separate the Carleton from the Caribou soils.

Caribou Series

Description.—The Caribou series is found chiefly in the northwest part of the map area, covering approximately 141,500 acres, and extends into the state of Maine. The soils which constitute the series are found on gently undulating to rolling topography at average elevations seldom exceeding 400 to 500 feet. The drainage is good both externally and internally and occasionally excessive, when the bed-rock comes close to the surface, or where the slopes are very steep. Erosion of these soils is very noticeable in many cultivated fields. On slopes where there are both cultivated and forested lands, it is not uncommon to find a fairly deep soil in the woods, whereas, in the fields, the subsoil or the bed-rock may come close to, or even reach the surface in spots. This condition is due to the removal of the topsoil by rain and run-off water. In the uncultivated state, the Caribou soils support mainly a deciduous vegetation, consisting largely of beech, maple, and yellow birch. When brought under cultivation, they are favourable for a wide variety of crops and are particularly well suited for potatoes.

The cultivated topsoil of the Caribou series is generally light brown to yellowish brown, the darker shade corresponding to a fairly high content of organic matter. The organic-matter content and the shade of colour vary considerably and are closely related to the length of time the soil has been under cultivation and to the management practices used. The structure of the soil is usually granular, often only slightly developed and sometimes scarcely noticeable. The topsoil is commonly open, friable, and dry, and contains fragments of shale and slate, many of them no larger than grains of sand. Cultivated fields are as a rule moderately to very acid (pH 5·5 to 4·5).

In the uncultivated state the Caribou soils have a thin dark-coloured layer near the surface, which contains much organic matter as indicated by the loss on ignition (see table 8, Appendix). The underlying, grey, leached layer contains usually very little organic matter, and is very acid. This layer is generally very thin and often hardly noticeable, while in some instances it forms pockets several inches deep. The subsoil grades from a light rusty brown to yellowish brown with depth and is not so acid as the surface soil. It often contains large shale or slate fragments with sufficient calcareous material to effervesce with acid, especially when the latter is applied to a fresh break. Smaller shale fragments, which have lost their calcareous material by weathering, are common throughout the profile.

Of the various types within the Caribou series, the Caribou heavy loam is the most extensive and the most important, covering some 123,500 acres. It is found chiefly in the northwest half of the map area, where it occupies the long, undulating slopes. The cultivated surface soil is of light brown colour, has a texture intermediate between a loam and a clay loam, and is open and mellow. Water-rounded stones and gravel are practically absent, but small fragments of

shale and slate are usually present. The heavy loam has good, though not excessive drainage. The supply of organic matter in old cultivated fields is often depleted. The pH of the cultivated surface soil is about 5·0. The following is a description of a representative, uncultivated soil profile.

Horizon	*Depth*	*Description*
A_0	0 ″ - 2 ″	Dark brown, fairly well decomposed layer of deciduous leaves, open, structureless. pH 5·2.
A_1	2 ″ - 2½″	Dark brown to black loam with high content of well decomposed organic matter. Friable and with granular structure. pH 5·2. Usually too thin to be sampled and often absent.
A_2	2½″ - 4 ″	Greyish white loam with considerable amounts of silt and shale fragments. The thickness varies from a trace to pockets of 2½″ or more. It is friable and has a slightly developed platy structure. Roots usually numerous. pH 4·6.
B_1	4 ″ - 9 ″	Orange to rusty brown loam, containing many well weathered shale fragments, which do not effervesce with acid. The soil is usually loose and mellow and has a fine granular structure, which often is not very well developed. Numerous roots occur in this and following horizons. pH. 4·8 - 5·2.
B_2	9 ″ - 16″	Greyish to yellowish brown loam. The colour of the B_2 horizon gradually shades from the rusty brown of the B_1 until it merges with the colour of the C horizon. The structure is not well developed. The soil is open and mellow. It contains considerable amounts of shale fragments. pH 5·0 - 5·4.
C	16″ -	Dark brown to yellowish brown or dark grey loam. It is open and friable, but somewhat firmer than B_2. This horizon consists largely of unaltered parent material and contains large quantities of rock fragments. pH. 5·4 - 5·6.

The Caribou light loam covers some 3,500 acres, and is found chiefly in the northern part of the map area east of the St. John river. It occurs on somewhat smoother land than the heavy loam. The cultivated surface soil is light brown, somewhat sandier than the heavy loam, but generally it appears to have slightly more organic matter and a little better structure. This may be because it is "newer" land and has been under intensive cultivation for a shorter length of time. The uncultivated profile is similar to that of the heavy loam, but does not appear to have resisted the leaching process quite so effectively; the A_2 is usually somewhat deeper and whiter, the B slightly more reddish, and the C is more compact.

The Caribou shaly loam covers some 5,500 acres. It is found on high, dry slopes and ridges in the northwestern part of the Woodstock district, and is formed partly from residual material. The bed-rock is comparatively close to the surface, and the soil is distinguished by an unusually high content of shale fragments and by frequent outcrops of shaly and schistose rock. The drainage is good to excessive. The cultivated surface soil is a yellowish brown, silty loam, structureless, but open and friable. It has a large content of shale fragments, the majority with a diameter of $\frac{1}{4}$-$\frac{1}{2}$ inch. The organic-matter content is low. The uncultivated soil is similar to the Caribou heavy loam, with the following modifications: the A_0 is very thin, but the A_1 is occasionally 3 inches thick, grey brown in colour. The B_1 is a yellowish brown loam. The C horizon consists mostly of more or less weathered shale fragments, resting on solid bed-rock.

The Caribou silty loam occupies about 900 acres. Its total extent is made up of small scattered areas occurring chiefly in the northern part of the map area west of the St. John river. This type is found closely associated with other Caribou types, usually on the very gently undulating land at the foot of slopes and ridges on which are found the heavy loam and shaly loam types. The silty loam is well drained, but not excessively so. The cultivated soil to plough

depth is light brown, mellow, and remarkably free from stones and large shale fragments, although smaller fragments about the size of small sand grains are numerous. In the uncultivated state, the silty loam is a deep soil, in many respects similar to the Caribou loam, but differs from the latter by reason of its silty texture and the distinct golden brown to orange colour of the B horizon.

Agriculture.—A large percentage of the total area of Caribou soils has been cleared and improved. Agricultural development on these soils has been rapid and a certain amount of specialization has taken place. Potato growing, for which purpose the soils are particularly suited, is the main source of cash income, which is supplemented by the sale of oats, hay, and dairy products. Wheat is grown for local milling and consumption. Table 5 affords a comparison between district B, where the Caribou soils cover practically all the cultivated land, and district C, where the Caribou soils have only a small distribution. This table shows that the average farm on the Caribou series has relatively large acreages of land improved and under crops and in pasture, and a relatively large number of live stock is kept per unit of occupied land. If improved land is used as the basis of comparison, it is seen that the farm on the Caribou soil has a relatively large acreage in crops, a small acreage in pasture, and small numbers of live stock, with the exception of swine. Potatoes, oats, and wheat occupy comparatively larger acreage and hay a smaller one on the Caribou soils than on the other soils.

The type of farm management followed on the Caribou soils usually makes provision for a five-year rotation: potatoes, grain, hay, hay, grain. There may be variations, such as a four-year rotation, or a five-year rotation with two successive crops of potatoes. This type of management requires the use of large amounts of artificial fertilizer. There are variations in the mixtures used, the 4-6-10 mixture being the most common, but many farmers use 5-8-10 or 5-8-7 analyses. The rate of application approaches an average of one ton per acre for potatoes. Grain and hay receive much less. The mixture used for crops other than potatoes are generally the 4-6-10 and 2-12-6 analyses, applied at the rate of 200 to 250 lb. per acre, but often hay and grain receive no fertilizer, the farmers considering the residual effect of the application given to the preceding potato crop to be sufficient. Lime is generally used in small amounts only, as the pH of a potato soil should not be higher than 5·2 or 5·4 in order to keep the scab organism under control. Usually the pH is below that level in the Caribou soils.

The yields of the different crops on Caribou soils vary greatly from farm to farm, depending on the practices which have been used and on the state of productivity which has been maintained or built up. If well managed and when fertilizers have been used at the rate of about one ton per acre, potatoes will yield on the average close to 100 barrels per acre and in some years the average yield is very much higher. Under poor management the yields are much lower. Oats vary in yield from 10 to 75 bushels per acre, and hay from $\frac{1}{4}$ ton of unpalatable weeds to 2·5 tons of succulent clover hay per acre, depending on the management practices which have been followed. The average yield of oats is close to 35 bushels, and for hay about 1 ton per acre.

These great variations in yield indicate that the fertility of many Caribou soils has been greatly depleted by poor soil management and farm practices. Potato yields have not only been maintained, but have been increased over a number of years by the use of heavy applications of fertilizers. In Aroostook county, Maine, applications as high as 3,000 pounds of mixed fertilizers have been used on Caribou soils with profitable returns. The large amounts of fertilizers over a period of years have increased the acidity of the already sour soils. The grain crops following such heavily fertilized potatoes are usually satisfactory, but the clover crops following the grain vary considerably depending on

FIG. 2.—View from Parks Hill, Houlton Road, showing typical topography of Caribou loam (on slopes) and Washburn loam (in wooded depressions).

FIG. 3.—St. John River Valley below Woodstock. The soil on the islands is Interval silty loam, while in the foreground and on the opposite slope is Riverbank sandy loam. The upper part of the slopes consists of Caribou loam.

FIG. 4.—Typical topography, near eastern boundary of the map area.

FIG. 5.—Caribou loam resting on unweathered bedrock (dark grey slate of Silurian age). Note steep dip and almost vertical cracks in rock.

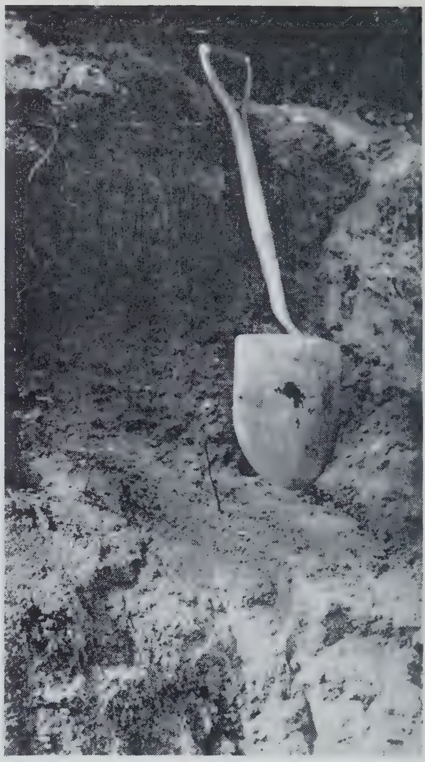


FIG. 6.—Pinder loam resting on semi-weathered bedrock (granite of Devonian age). Note coarse texture of weathering material.

FIG. 7.—Erosion on Riverbank fine sandy loam near St. John river. Note deposits of fine valuable soil at bottom of field. Cultivation should be across the slope, not up and down.

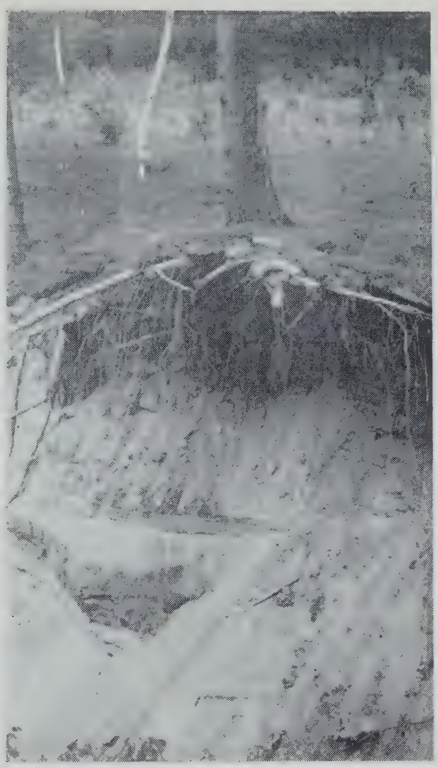


FIG. 8.—Incipient erosion gully on thoughtlessly cleared hillside. Note stand of trees in background.

FIG. 9.—Riverbank sandy loam. Note stratification (layer of silty material) lack of structure, and erodibility.

FIG. 10.—Cleared gravelly knoll on which trees should be growing. Pastures usually are poor and erosion sets in.

FIG. 11.—Gagetown gravelly loam, cultivated.

FIG. 12.—Limestone rock, exposed near Ashland, Carleton Co. Note dip and thin stratification.

FIG. 13.—View of Little Presquile River, near Centreville. Note beds of Silurian shale.

additional treatments, and the general state of fertility of the soil. The second year hay crop is almost invariably poor unless some special measures have been used. Only too often, so-called hay fields can be observed in which up to 90 per cent of the vegetation consists of poverty grass, hawkweed, sorrel and daisies.

The farm practices outlined above, which aim at high potato yields even at the expense of normal hay crops, do not provide for the incorporation of sufficient new organic matter into the soil, nor for the preservation of existing humus levels. The limited number of live stock kept on many farms does not provide the amount of manure which the soils require. As a result of these conditions, and due to the natural tendency of the well-drained, well-aerated Caribou soils to lose their organic matter on cultivation, many intensely farmed soils have been seriously depleted in organic matter and nitrogen. One of the main objectives should be to build up and maintain the organic-matter content at a satisfactory level. This can be done by the use of greater quantities of barnyard manure, if such is available or by the ploughing down of green manure. In cases where the organic matter is very low, and where the soil is very acid good crops of clover, which would provide good aftermath to be ploughed down, cannot be established. In such cases, the growing and ploughing down of special crops, such as buckwheat, can be resorted to. For intensive potato growing in Aroostook county, Maine, annual crimson clover has been used in a two-year rotation with potatoes. The clover is not harvested for hay, but the entire crop is ploughed down as green manure. This practice has not been tried in Canada. In longer rotations the addition of some lime to establish a good clover crop is to be recommended. Too much lime, however, is injurious to the potato crop, but experiences on Caribou soils in Aroostook county, Maine, indicate that finely ground limestone at the rate of 1,000 pounds per acre is not harmful if applied 2 or 3 years prior to the planting of potatoes.

Caribou soils with a good organic-matter content usually produce better and more uniform crops, especiallly of hay and grain. The increased organic matter helps to hold the added fertilizer, preventing it from leaching excessively out of the soil, and effects a reduction in the amount of nitrogen needed in the fertilizer mixture. A high organic-matter content of the soil is also of great importance in checking soil erosion by absorbing some of the run-off water.

Erosion of the Caribou soils is a problem, which has as yet received little attention, but which is becoming increasingly serious, as has been found to be the case in the neighbouring county of Aroostook, Maine, where a Soil Conservation Project was established at Presque Isle in 1936. Erosion is particularly noticeable on the heavy loam and the shaly loam. In several fields the topsoil has been almost entirely removed by run-off water. This effect is liable to escape notice, as the soil is washed away largely by sheet erosion, which removes a thin layer from large areas after each rainfall. Gully erosion, which cannot fail to be noticed whenever it occurs, is less common. The loss of surface soil has been accelerated by the extensive removal of forest vegetation and subsequent cultivation up and down the slopes and by the lack of sufficient grass, clover, and other soil conserving crops in the rotation. The natural productive capacity of the soils has been impaired by erosion, although this ill-effect has been masked by the increasingly heavy applications of fertilizer, especially since the close of the war in 1918.

The Caribou soils are almost ideally suited for a combination of potato growing and dairy farming, but their tendency towards erosion and their lack of organic matter must be remedied, if a stable, profitable industry of agriculture is to be continued. The factors responsible for erosion, such as rainfall, slope, and the parent material of the soils, are beyond human control, but the effects of those factors can be checked. The methods of erosion control are varied, and can be adapted to any particular farm. The method used should combine the features of efficiency in checking run-off down a slope, convenience

in the farm management, and low cost to the farmer. The most important and necessary step in the control of erosion is putting each field in the crop or rotation of crops to which it is best suited. If a slope is too steep for profitable cultivation, even with improved practices, it should be turned into well-sodded pasture, or if that is impossible, it should be planted to trees. To stop run-off or make it harmless, it is necessary to plough and till the land across the slope rather than up and down hill, the latter practice resulting in the formation of channels in which water may run unhindered to the bottom of the grade. Tillage across the slope has the added advantage of requiring less power to pull the machinery. Secondly, crops should be planted in long and relatively narrow bands of approximately equal width, which may vary from 50 to 125 feet, depending on the degree of slope. Clean-tilled crops, such as potatoes and roots, should be alternated with grass, small grains, and legumes, so that water coming from the clean-tilled strips is checked in its flow by the close-growing crops and is afforded an opportunity to soak into the soil. One difficulty in the way of instituting these erosion control practices had its origin in the manner in which the farms were laid out, with a narrow frontage on a river or a road and extending far back over a slope.

Carleton Series

Description.—The Carleton soils cover approximately 90,000 acres and occupy well drained ridges and slopes in the southeastern half of the map area. They are located on undulating to strongly rolling topography, the heavy soils occupying the former terrain and the lighter, stony types occurring on the more broken land. They are all well drained and show no indication of mottling in the subsoil, but the drainage is slow, especially in the heavier soils, and they retain more moisture than the Caribou soils. There is a tendency towards erosion, and gullies are often formed, but the prevailing type of agriculture, which is mainly mixed farming, and the fact that only a relatively small percentage of the land is cleared, are factors tending to prevent sheet erosion and preserve the topsoil. The parent material of the Carleton series is of much the same nature as that of the Caribou soils, but it was moved farther by the glaciers and became modified more than the latter. Shale and slate fragments are not so common in the profile, which contains more sandstone and sometimes rocks from other formation. The soils are generally more compact, more strongly podsolized, and contain fewer bases than the Caribou soils. Cultivated surface soils are usually light brown to brown in colour. The texture often varies from a clay loam on gentle slopes to a light loam on steeper land. There is generally a fairly well developed granular structure. The amounts of gravel and stones vary considerably.

Two types have been mapped within the Carleton series; the clay loam (to clay) and the loam. The loam is the more extensive and the more important type. It covers some 81,000 acres of undulating to rolling upland and is distributed chiefly in the southern and eastern parts of the surveyed district. It is well drained and supports a mixed vegetation of hardwoods, such as maple and yellow birch, and softwoods, among which spruce predominates. The Carleton loam has been cleared and brought under cultivation where the topography of the land permits, but a large part of it is too stony and on too steep slopes to justify attempts at improvements. A cultivated surface soil of the Carleton loam is light brown to brown and usually has a fairly well developed granular structure. The organic-matter content and the darkness of colour vary with farm practices. The organic-matter content of the cultivated Carleton loam is generally greater than that of the Caribou soils. This is probably to a large extent due to the fact that potato growing is not so extensive on the Carleton soils and that in many cases the Carleton loam has not been under cultivation as long as the majority of the Caribou soils. The uncultivated

Carleton loam under forest has the appearance of a typical podsol soil with a white leached layer under the leafmat. The following is a description of a typical virgin Carleton loam profile:

Horizon	Depth	Description
A_0	0 – 2″	Dark brown, structureless mat of decomposing organic matter, derived from a vegetation of mixed hardwoods and softwoods. pH 4·0.
A_2	2″– 4″	White or greyish white loam, with a certain amount of fine, flour-like material. Platy structure is often noticeable. pH 4·2. The thickness of this layer varies from ½″ to 3″.
B_1	4″–10″	Orange brown to rusty brown loam, often with a yellow cast. The layer is open and friable and has a weakly developed granular structure. It usually contains a little gravel and a few sandstone fragments. Roots are numerous. pH 4·8.
B_2	10″–26″	Pale brown to reddish brown loam. This horizon is friable and usually has a granular to firm nutty structure. pH 5·4. Occasionally there is sufficient variation between the upper and the lower portions of this horizon to subdivide it. In such cases the lower portion is called B_3 and forms a gradual transition between the B and the C horizons. It has a yellowish grey colour, a good nutty structure, and is somewhat compact, containing some gravel and angular sandstone fragments. pH 5·6.
C	26″–	The subsoil is a yellowish grey loam to clay loam. It usually contains some shale and schistose rock fragments, as well as rounded gravel and sandstone boulders. The consistency varies; but in some profiles there is less compactness and a cloddy structure. Movement of water through the C horizon is slow. As a rule roots do not penetrate deeply into the subsoil. pH 5·7 – 6·0.

In a few localities, a gravelly phase of the loam occurs. The profile of this phase is similar to that of the loam, but contains more gravel, which tends to make the subsoil slightly less compact and more arid.

The second member of the Carleton series, the clay loam (to clay), has a much smaller distribution than the loam. It covers about 9,000 acres, and often occupies the more level and smooth positions of a topographical pattern in which the loam is found on the steeper land. The drainage of the clay loam is fairly good but slow due to the heavy texture and the lack of porosity of the soil. Usually the clay loam is well supplied with organic matter and soluble bases. The cultivated soil is dark brown, has a good granular structure and is comparatively free from gravel and stones. It erodes easily if not covered by vegetation. The uncultivated soil usually has only a thin dark brown to black layer of organic matter, but following it there is a 4-inch layer, the A_1 horizon, which is black clay loam to clay, containing large amounts of well decomposed organic matter. The A_2 horizon is a thin layer of yellowish grey clay with a granular structure and fairly high reaction. The B_1 often has a thickness of 11 inches to 12 inches. It is a yellowish to dark brown clay loam to clay with a granular to fine nutty structure. The reaction of the B_1 reaches a pH of 6·2. The B_2 is a yellowish brown clay or heavy clay loam with a nutty structure, and contains some gravel and angular shale and sandstone fragments. This horizon is somewhat compact and, in some profiles, slightly mottled. The subsoil begins at a depth of 22 inches and consists of yellowish grey clay, which is rather compact, but crumbles easily into nutty aggregates on exposure to the air. It contains some stones and gravel. The C horizon is somewhat impervious, which condition constitutes a limiting factor in the internal drainage of the soil. The reaction is commonly about pH 6·6.

Agriculture.—The Carleton soils are used chiefly for general farming purposes, although a certain acreage is planted to potatoes, especially on farms that contain also soils of the Caribou series. The statistics given for district C in table 5 are applicable chiefly to the state of agriculture on the Carleton soils, as they form the most important farming land in that district. It is seen

that only about 62 per cent of the land is occupied, and of that acreage only 43 per cent is cleared and improved, which leaves about 73 per cent of the entire district in forest and other forms of unimproved land, as compared with about 44 per cent in district B. It is, therefore, only natural that woods operations should play an important part in the farm economy. The sale of dairy products is the main source of income, and the farm management is arranged accordingly. Relatively large numbers of live stock are kept, which necessitates a large acreage in pasture. Hay and oats are the chief crops and are grown for home consumption. Farms on Carleton soils usually employ long rotations, in which hay and grain predominate, and which generally include smaller acreages of clean-tilled crops, such as roots and potatoes; the latter are mainly grown for home consumption and sometimes also for sale. Potatoes grow quite satisfactorily on the loam, but the Carleton soils are not as well adapted for this crop as the Caribou soils.

The natural fertility of the Carleton soils is fairly good, but the present level of productivity varies considerably, depending to a large extent on the management practices which have been used. The clay loam soils, partly due to their higher organic-matter content, higher reaction, heavier texture, greater moisture holding capacity and comparatively lesser leaching are better adapted to grain, hay and roots, but less so for potatoes than are the lighter soil types. The average yields of hay, both clover and timothy are much higher on the clay loam than on the Carleton loam or on the Caribou soils. Hay fields containing a dominant cover of poverty grass, paint brush and sorrel hardly ever occur on the clay loam. Oats and barley yields are also very good on this soil provided some commercial fertilizers are used. Most of the clay loam soils are devoted to mixed and dairy farming for which purpose they are very well suited.

The present level of fertility of the Carleton loam varies considerably more than that of the clay loam. On well managed farms, where a good rotation has been used, and where the applications of manure and small quantities of mixed fertilizers are regular practices, the grain and hay yields are very good. The same statement applies to loam soils which have been under cultivation for a comparatively short period of time, and where the natural fertility of the land has not been greatly depleted. However, on quite a number of farms no definite crop rotations are practised, and the hay is often left in meadows for 4 or 5 years or more. In such cases the yields and the quality of the hay become progressively poorer, eventually resulting in thin, weedy stands in which poverty grass, paint brush, and sorrel dominate. Due to the thin cover, the soils on the steeper slopes become subject to erosion. The stock-carrying capacity of such farms is greatly reduced, and, as a result, less manure is available for the land. The organic-matter content and the general fertility levels of such soils become rapidly depleted, and the grain crops are usually poor.

The Carleton loam soils are distinctly acid, and applications of finely ground limestone, at the rate of 1 to 2 tons per acre, are to be recommended, provided the land is not intended for potato growing. Dolomitic limestone is to be preferred, as these soils are often deficient in magnesium. The clay loam soils, which are only slightly to moderately acid, do not require lime in the same amounts as do the loams, although applications up to one ton per acre are often beneficial for clovers. The Carleton soils erode readily, and if they are subjected to conditions which accelerate erosion, such as planting hoed crops up and down the slopes, allowing the depletion of organic matter, and the presence of thin weedy hay meadows on steep slopes, erosion damage is distinctly visible. Generally, however, the erosion damage is much less on the Carleton soils than on the Caribou soils. Good mixed farming practices involving the use of barnyard manure, the ploughing down of good hay aftermaths, and the use of lime and some commercial fertilizers, should maintain the Carleton soils in a high state of fertility and prevent serious soil erosion. The steeper slopes should be devoted to permanent pastures or returned to forest.

(b) *Ill Drained Soils*

The poorly drained Washburn soils are closely associated with the Caribou and the Carleton series. The existence of two different parent materials should normally lead to the formation of two ill drained series under conditions of poor drainage. However, a careful examination in the field revealed that in this case high groundwater charged with lime and other bases has been an overwhelming factor in the development of the soils on both parent materials and that this condition has obscured the effects of the small differences in the parent materials. For all practical purposes the poorly drained soils on both parent materials can be considered as one soil series which is associated with both the Caribou and the Carleton series. The poorly drained soils are usually found on the lower topographic positions, near the bottom of long slopes, along drainage channels, and in depressional areas. The moist condition of these soils and the presence of a high water-table as well as the influx of lime and other bases with the drainage waters from the surrounding higher lands have greatly reduced the leaching processes which are so characteristic of the better drained soils in this area. The Washburn soils lack the characteristic white layer of the well drained, leached soils and for this reason they cannot be considreed as podsol soils. They are, instead, intrazonal soils, i.e., soils in which, due to local conditions, in this case high water-table and influx of lime, the zonal characteristics have not been able to develop. Such soils are often referred to in the literature as "Half Bog" soils.

Washburn Series

Description.—This series covers approximately 140,500 acres, and is found, as already mentioned, in close association with the Caribou and the Carleton series, at the base of slopes, in depressions, and on low land adjoining water-courses. Due to the flat relief and the low level of the land, the drainage of the Washburn series is impeded to poor. The uncultivated areas are usually covered with a fair to stunted growth of cedar, tamarack, and black spruce, and also, occasionally fir, poplar, and elm. When one stands on a ridge viewing the country below, it is possible to get a fair idea of the extent of ill drained soils by noting the outlines of the dark green vegetation, which is in notable contrast with the brighter green growth on the well drained land.

The parent material of the Washburn series is geologically similar to that of the Caribou and Carleton soils, but the cold, wet soil climate produced by restricted drainage has resulted in soils with entirely different characteristics. The soils of the Washburn series vary somewhat in their morphological characteristics, due to differences in the degree of ill-drainage, but the average pattern of these variations is confined to definite limits. On the one side, the Washburn soils grade into the well drained Caribou and Carleton soils, while on the other side, they gradually change through a swampy phase to muck and peat. The transition from well drained to ill drained soils is fairly sharp and the boundary line can be easily established. The peat and muck soils have been mapped separately, and are discussed under "Organic Soils". A soil having a covering of 12 inches or more of organic materials has been designated as peat or muck.

The cultivated surface soil is usually dark brown to black due to a high content of organic matter; the structure is granular, often somewhat coarse, and the pH is high, generally between 6·0 and 7·0. In the uncultivated state, the Washburn series has a layer of varying thickness of black, semi-decomposed organic matter, followed by an A_1 horizon 5 to 10 inches deep, consisting of a dark, chocolate-coloured to black clay or clay loam. The dark colour is derived from a high content of organic matter. The structure of this layer is

granular and well developed. The B horizon is commonly yellowish to greyish brown, with varying degrees of reddish brown mottling. The structure is usually coarse granular or nutty. The consistency varies from friable to somewhat compact, depending on the moisture content. Small amounts of gravel, sandstone and shale fragments are generally present. The pH is about 7·0. In profiles that are always saturated with moisture the B horizon does not exist as such. In its place is found a "G" or "glei" horizon. It is a greyish yellow (or discoloured) clay loam. Mottling is indistinct due to the saturated condition of the soil. There is little to no structure, and the layer is fairly compact. The C horizon is usually a yellowish grey to greyish brown clay loam to clay, mottled, with a somewhat massive structure, compact and stony. The pH of this subsoil ranges from 7·0 to 8·0.

The Washburn series contains two types, the clay and the clay loam; a swampy phase of the latter also occurs. The clay loam is more common than the clay and conforms generally to the following description:

Horizon	Depth	*Description*
A_0	0 – 2″	Fresh and semi-decomposed black organic matter, largely from coniferous needles. pH 5·6 – 6·0.
A_1	2″– 8″	Black clay loam, high in organic matter, with granular structure, fairly open and friable. pH 6·5 – 7·0.
B_1	8″–14″	Yellowish grey to brownish grey clay loam, mottled, with granular to nutty structure. Usually slightly compact but friable when dry. Small amounts of gravel and stones. pH 7·0 – 7·5.
G	14″–18″	Yellowish grey clay loam, strongly mottled, with slightly developed coarse nutty structure, and usually compact. Gravel, sandstone and shale or slate fragments are quite numerous. Groundwater is often encountered in the lower part of this horizon. pH 7·5 –
C	18″	Yellowish grey clay loam to clay, structureless to massive compact, with much gravel and stones.. pH 7·5 – 8·0.

The Washburn clay differs from the preceding description by having a heavier texture in the upper horizon, and by having a uniform B horizon, which is usually not divisible into sub-horizons.

The swampy phase is a transition between the clay loam and the organic soils. It exhibits considerable variation between profiles, but due to the lack of economic importance of the phase no finer distinctions were made. The swampy phase is under water over long periods of the year and generally has a very high water-table even during the summer. It is often covered with up to 10 or 12 inches of moss or peat, and the mineral soil has a thin, greyish, mottled layer immediately below the mat of organic matter, below which no horizon distinction can be made. This phase is unsuitable for agriculture purposes.

Agriculture.—The Washburn series is under cultivation only to a small extent, because of its poor drainage conditions. Where it has been cleared and cultivated it generally occurs in strips between two well-drained sections of a field and has been improved mainly to facilitate the passage of farm machinery from one section to the other. The Washburn soils are not suitable for potato growing on account of the high reaction, which favours the growth of scab, but very often the better drained phases of these soils produce excellent crops of clover and timothy hay. In dry years and in fields where drainage has been improved, very good oat yields can be obtained. In wet years, and in fields where drainage has not been improved, the soil is often too wet and cold in the spring and the grain yields are poor. The Washburn soils are in many cases used for pasture, but if the stock is turned out while the soil is wet, the cattle usually break the sod leaving a rough, hummocky field. When newly cleared the Washburn soils are usually wet. With cultivation the water-table is, in

due time, lowered, and the drainage conditions improve somewhat. This improvement can be greatly speeded up by the use of tile drains and open ditches.

The Washburn soils have a high content of organic matter and of nitrogen. They have a slightly acid to neutral reaction and a fairly good supply of bases. Erosion is not significant or non-existent on these soils, but accumulations of material eroded from the adjacent Caribou and Carleton soils are frequently found. The Washburn soils have a high natural fertility, but their utilization and their productiveness are limited by the poor drainage. Under-drainage by means of tiles is an effective remedy, but it may be economical only in certain cases. The establishment of open surface drains is recommended, but they may not always be sufficient.

II. Soils developed on reddish brown to red clay loam to clay till derived mainly from calcareous, red, fine-grained sandstones, shale and conglomerate of Carboniferous age

Kingsclear—Nackawic Association

The soils of this association occupy only about 800 acres and are located in the general vicinity of Carlisle. Their characteristic red parent material has been derived mainly from the underlying rocks, which consist largely of red calcareous conglomerate, shale, and fine-grained sandstone. The calcareous nature and the heavier texture of these materials have greatly influenced the characteristics of the soils developed on them and serve as a basis for the separation of the latter from other soils, also formed from reddish Carboniferous parent materials.

This association consists of two soil series which form a natural land pattern. The Kingclear series occupies the well drained, elevated positions, while the Nackawic soils are found in the more poorly drained positions on gentle slopes and in depressions.

(a) Well Drained Soils

KINGSCLEAR SERIES

The Kingsclear series constitutes the only well drained soils which have been mapped on the calcareous Carboniferous materials. Soils of this series occupy only about 500 acres in the surveyed area, but are also found in isolated places in other parts of the province. The topography of these soils varies from undulating to strongly rolling and hilly, but only a comparatively small proportion of the Kingsclear soils in the Woodstock area are on the smoother relief. Stones and boulders usually occur on these soils especially on the rougher topography. The external drainage is good to rapid, and the internal drainage is also fairly good, but much slower than in the Caribou soils. Only a small percentage of the land has been cleared and the natural vegetation consists of mixed soft and hardwoods.

The cultivated Kingsclear soil is a brown to reddish brown clay loam. It has a granular structure and is friable. The subsoil consists of brick red clay loam to clay with a slightly developed granular to nutty structure. It is firm but not compacted. On steep slopes where some of the surface soil has been eroded, the soil is distinctly red, the intensity of the red colour indicating the extent of erosion.

The uncultivated virgin soil has a thin black layer near the surface under the forest leaf mat. This is underlain by a leached A_2 horizon, which is greyish-brown or grey with a reddish cast in colour and is seldom white as in the case of the Caribou or Carleton soils. A more detailed description of a typical

Kingsclear clay loam, which is the only soil type mapped in this series is given below.

Horizon	Depth	*Description*
A_0	0 – 1″	Dark brown to black, semi-decomposed leaf mat of softwood and hardwood origin. pH 5·0.
A_1	1″–2½″	Black, well-decomposed organic matter, mixed with mineral soil. Granular structure, friable, pH 5·5.
A_2	2½″– 4″	Dark greyish brown clay loam, structureless or with slight appearance of platy structure, open and friable. pH 5·2.
B_1	4″–16″	Dark brownish red clay loam, with slightly developed structure, varying from granular to nutty in size. Friable consistency. pH 5·8.
B_2	16″–24″	Bright red clay loam with poorly developed granular to nutty structure. Firm, but not compact. Many stones and fragments of conglomerate. pH 6·0.
C	24″–	Brownish to dull red clay with coarse nutty structure. Somewhat compact. On drying the soil becomes brick red. pH 6·2.

Agriculture.—Due to its stony nature and rugged topography very little of the Kingsclear series is under cultivation. On the smoother land, where the stones have been removed, the soil is well suited for general farming purposes. The soil generally has a fairly high fertility level, as it contains liberal amounts of organic matter and nitrogen and has a fair supply of bases. The reaction of the soil is moderately acid and is much higher than that of the Caribou or Carleton soils. With good management practices, including the use of manure and light applications of commercial fertilizers, the soil will remain highly productive for a long time. The yields of oats and barley are fairly high on this soil, when it is well managed. Because of the favourable reaction and the reasonably slow internal drainage, this soil produces excellent crops of clover and timothy hay, but for the same reasons it is not so well suited for potato growing as the Caribou soils.

Soil erosion is not very serious on the Kingsclear soils as the cultivated fields are small and most of the land is wooded due to its stoniness and broken relief. Only on the steeper land which has been cleared is erosion noticeable, and this can be checked to some extent by the use of cover crops and proper rotations.

(*b*) *Ill Drained Soils*

NACKAWIC SERIES

The Nackawic series is of very small extent, covering only about 350 acres in scattered locations near the village of Carlisle. It occurs in close association with the Kingsclear clay loam, occupying the lower slopes and depressional to level areas. Due to its position and smooth topography the Nackawic series has little or no run-off. Poor drainage conditions are aggravated by slow internal movement of water and the influx of drainage waters from adjacent land. The vegetation on this series consists of shrubs and a stunted growth of coniferous trees, largely spruce and tamarack. The parent material of this series is similar to that of the Kingsclear soils, consisting of reddish clay loam till which has been derived mainly from calcareous Carboniferous rocks, but due to the poor drainage conditions the appearance and the characteristics of the Nackawic soils differ greatly from those of the associated Kingsclear series. A continuous influx of drainage waters charged with lime and other bases and a high water-table during a considerable part of the year have prevented any appreciable leaching in the Nackawic soils, as was also the case in the Washburn series. The absence of a grey, leached A_2 horizon differentiates the Nackawic soils from the typically leached podsol soils of the region. The presence of a dark surface layer and of a badly discoloured and mottled subsoil are more characteristic of the so-called intrazonal, "half bog" soils.

Practically all of the Nackawic soils are in bush, and only narrow strips which extend into well drained fields have been brought under cultivation. Such cultivated land which has been improved by artificial drainage has a black, granular, and friable surface soil. The uncultivated land is often swampy. A detailed description of a representative clay loam, which is the only soil type mapped in the Nackawic series, is given below:—

Horizon	Depth	*Description*
A_0	0 – 2″	Dark brown to black mat of leaves and partly decomposed organic matter, moist, interwoven with roots. pH 4·5.
A_1	2″– 6″	Black clay loam with a high percentage of organic matter. Good granular structure. pH 5·5.
G	6″–14″	Light greyish brown structureless clay loam. It has a strongly mottled appearance and along old root channels often occur rusty red and dark concretions, which probably consist of iron humates. This layer is usually referred to as a "Glei" horizon in order to distinguish it from a better drained B horizon. It is the zone of a fluctuating water-table, and the discoloration is attributed to alternating reduction and oxidation of the soil.
C	14″–	Reddish brown clay loam. No evidence of structural development in the natural state. Rounded gravel and stones are imbedded in the massive subsoil. This layer is below groundwater level. On drying it becomes very hard and assumes a brick red colour. pH 7·2.

Agriculture.—The Nackawic soils are not naturally suited for agricultural purposes, and only where the drainage conditions have been improved by artificial means do cultivated crops grow satisfactorily. The installation of tile underdrains is expensive on this soil due to the presence of stones and boulders, and it is probably economical only in cases where narrow strips of Nackawic soils break the continuity of well drained fields. Open ditches, if properly located, are of considerable value in improving the drainage condition of this soil.

The Nackawic clay loam has a high natural fertility and has an abundant supply of organic matter and nitrogen. The cultivated surface soil is slightly to moderately acid, but the reaction of the subsoil is close to neutral. The soil is usually too wet for grain, and the crops grow very rank and often fail to mature. The yields of hay crops, both clover and timothy, are usually good, if drainage conditions have been improved. The soil is often used for permanent pastures, and it produces a good sward, if the stock is kept off, while the ground is excessively wet.

III. Soils developed from reddish brown to red loam to sandy loam till which has been derived mainly from the underlying reddish brown, coarse-grained sandstone and sandstone conglomerate of Carboniferous Age

Parry-Midway Association

The soils of this association occupy somewhat over 7,300 acres in the surveyed area and are located in the general vicinity of Carlisle, Cloverdale, and Howard Brook. The parent material from which these soils have developed resembles that of the Kingsclear-Nackawic Association somewhat in colour, although generally the parent materials of the latter soils are a somewhat brighter red. Both tills have been derived from carboniferous rocks, but the till of the Parry-Midway association contains very little lime, whereas the till of the Kingsclear-Nackawic soils contains considerably more lime thus resulting in soils with a much higher reaction. The till of the latter soils is usually considerably heavier in texture than the till of the Parry-Midway soils.

The area in which this soil association has been mapped has a hilly and rugged appearance. Some of the hills are high, with steep and abrupt slopes, but most of the hills have fairly long and more gentle slopes with undulating land on top. The hills are in some cases separated by prominent, narrow river valleys, while in other cases more extensive, gently sloping depressions with poor drainage outlets separate the hills. In some of the more prominent valleys water laid deposits have accumulated, and in other cases the glacial till has been partly sorted and redeposited by water. The soils formed on such materials are not included in the Parry-Midway Association.

This soil association consists of two soil series which form the natural land pattern. The Parry series occupies well drained elevated positions, and is often quite rugged, while the Midway series is found in the adjacent more poorly drained positions on the lower, more gentle slopes and in depressions. For practical purposes, some of the rugged tracts have been designated as rough, stony land which is discussed in another section of this report as a separate land class.

(*a*) *Well Drained Soils*

PARRY SERIES

The soils of the Parry series occupy approximately 3,500 acres in the surveyed area. The topography varies from undulating to rolling or hilly. Stones and boulders occur frequently and occasionally large slabs of conglomerate are found on the surface. Some of the smoother fields, however, are comparatively free of stone. The cover of the till over the bed-rock is usually more than 4 feet in depth, but in some cases, the underlying sandstone and conglomerate is found much closer to the surface. The surface drainage is good to rapid and the internal drainage is also good, the soil being friable and porous, permitting free percolation. The forest vegetation consists of mixed hardwoods and softwoods, with a slight dominance of the latter.

Only one type, the Parry sandy loam, has been mapped in this series, although the soil varies from a sandy loam to a light loam. In some locations the soil contains appreciably more gravel in the B horizon and has a somewhat lighter surface texture than the average sandy loam. Such occurrences have been mapped as a gravelly phase of the sandy loam.

The cultivated surface soil of the sandy loam is light brown to greyish brown in colour. It has a granular structure, and is open and friable. The subsoil is reddish brown and very porous and friable. In the uncultivated, wooded state this soil has a distinctly leached grey A_2 horizon under the mat of forest litter. A more detailed profile description of a representative virgin Parry sandy loam is given below:—

Horizon	Depth	*Description*
A_0	0 – 1½″	Dark brown, semi-decomposed organic matter consisting of remains of coniferous and deciduous vegetation. pH 4·6.
A_2	1½″– 4 ″	Ash-grey sandy loam, structureless, open and friable, with some small stones, mainly red conglomerate. pH 4·2.
B_1	4 ″–19 ″	Reddish brown sandy loam with slight granular structure in lower part of horizon, open and friable. Some gravel and conglomerate rocks. pH 5·2.
B_2	19 ″–32 ″	Light brown (with brick red tinge) sandy loam to loam with poorly developed granular structure, open and friable. Some gravel and conglomerate rocks. pH 5·3.
C	32 ″–	Reddish brown loam, structureless and slightly compact. Usually this subsoil is thin and rests on the parent rock of red conglomerate. Occasionally the bed-rock is found immediately under the B_2 horizon pH 5·5.

The gravelly phase retains less moisture because of its greater porosity and is often somewhat lighter in colour and lower in organic matter than the typical sandy loam. The extent of leaching, as indicated by the depth of the grey A_2 horizon in the virgin soil, is usually somewhat greater in the gravelly phase than in the normal sandy loam.

Agriculture.—The percentage of the Parry soils under cultivation in the surveyed area is relatively small and therefore information regarding the adaptability and the requirements of these soils is limited. The general fertility level of this soil type is relatively low as it has been quite severely leached. On the steeper slopes the soils are often very dry, and the crops frequently suffer from drought. The organic matter and nitrogen contents are not very high, and the reaction is distinctly acid.

Most of the improved Parry soils are devoted to general mixed farming, and lumbering also plays an important part on many farms, especially during the winter months. Grain, hay and pasture are the chief crops grown, and potato production is of minor importance on most farms, being sufficient for home consumption only. The yields of the crops vary considerably from field to field. In some fields fairly good crops of hay and grain are produced, while in others the crops are very poor and consist chiefly of weeds. The variations can be attributed to a large extent to differences in farm practices and soil management. Due to the poor natural fertility, yields drop rapidly after the land is brought under cultivation, unless the fertility is built up and maintained by proper management. The use of finely ground limestone is a prerequisite for the successful production of hay and grain, and the application of manure and the ploughing down of good aftermath help to build up and maintain the organic matter and nitrogen in the soil. The use of commercial fertilizers in addition to the before-mentioned treatments will usually ensure a satisfactory crop. The type of fertilizer mixture that should be used depends on the kind of crop, and on the amount of manure which has been applied. Good quality potatoes can be grown on this soil, but the yields are usually much lower than on the Caribou soils.

Soil erosion is often a serious factor on steeper slopes which have a thin and weedy crop. The most economical measures of control are the establishment of a good, healthy crop, especially hay, cultivation across the slope, and the use of a proper rotation involving strip cropping. Some of the steeper slopes should not be cultivated but used as permanent pastures or returned to forest. A considerable proportion of the Parry soils which is still in woods is not well adapted for farming purposes. The rugged topography, the presence of numerous stones and boulders, and the low fertility of the land would make the clearing and cultivation of such soils uneconomical at present

(*b*) *Poorly Drained Soils*

MIDWAY SERIES

This series covers an area of approximately 3,850 acres, most of which is in forest. It is found in close association with the Parry soils, occupying the low-lying and depressional areas on level to gently rolling topography. Stones and boulders occur frequently throughout the soil and on the surface. The natural vegetation consists largely of fir, black spruce, cedar, and alder. The parent material of this soil is similar to that of the Parry series, consisting of a sandy loam to light loam till which has been derived mainly from red carboniferous sandstone and sandstone conglomerate. The appearance and characteristics of the Midway soils, however, differ markedly from those of the Parry soils because of poor drainage conditions. Unlike the poorly drained Washburn and Nackawic soils, which have been discussed previously, the Midway soils have

a distinctly leached grey A_2 horizon under the darker surface layer. This development has proceeded unhindered due to the scarcity of free lime in the drainage waters which the soil receives from the adjacent, higher land.

Only one soil type, the Midway sandy loam, has been mapped in this series. Where the land has been cultivated the surface soil usually consists of dark brown to black friable sandy loam with light grey patches scattered through the field. On these grey patches, the original dark surface layer did not extend to the entire plough depth and the grey A_2 horizon has been turned up by the plough.

In the uncultivated state the soil is covered with a dark brown mat of forest litter, the A_0 horizon, about 2 inches in thickness. This material consists of partly decomposed needles, leaves, moss, and dead and living roots. The leaf mat covers a layer of black loam, the A_1 horizon, 3 to 6 inches in thickness, which consists of mineral soil intimately mixed with well-decomposed organic matter. When not too wet this layer is very friable and has a good granular structure. The A_1 horizon is underlain by a sharply defined, light grey to white layer, the A_2 horizon, which varies from 2 to 5 inches in depth. It is friable but has no definite structure. Below the grey layer, a reddish brown sandy loam, the B horizon, extends to a depth of about 20 inches. Bright and dark patches in the soil give it a strongly mottled appearance, which is due to poor drainage conditions, but generally the drainage of this soil is better than that of the Nackawic soils. Usually, there is no appreciable difference between the upper and the lower part of the B horizon. The soil is fairly loose and friable and has a slightly developed granular structure. The underlying substratum or C horizon consists of reddish brown sandy loam to loam. It is slightly darker than the B horizon, but becomes distinctly brick red in colour when dried in the air. This material has no definite structure and is somewhat compacted. It contains somewhat more gravel and more fragments of red sandstone and sandstone conglomerate than the upper part of the profile. The reaction of the surface soil is very acid, about pH 4, while the subsoil is less acid having a pH of about 5·5.

Agriculture.—Practically all of this soil is in forest. Owing to its poorly drained condition it does not lend itself to the production of farm crops in the ordinary growing season, unless the drainage conditions are greatly improved. The installation of artificial drainage systems is hardly worthwhile in view of the low level of fertility, the acid reaction, and the stoniness of the soil, except in swales and depressions in an otherwise well-drained field. With improved drainage the Midway series makes fair hay and pasture land.

IV. Soils developed from reddish brown slightly sorted, modified, sandy loam till, derived largely from red sandstone and sandstone conglomerate of Carboniferous Age

Becaguimec—Snyder Association

The soils of this association occupy approximately 12,000 acres and are located in the same general area as the soils of the Parry-Midway association. While the latter occupy the higher positions, the Becaguimec and Snyder soils are found on gently undulating relief at relatively low elevations, chiefly in the vicinity of the South Branch of the Becaguimec river. The parent material has the same reddish brown to red colour as the adjacent Parry soils, and it appears to have derived from similar Carboniferous sandstone and conglomerate. It has, however, been considerably modified by the action of water, and occasionally it has been sorted to a considerable degree as indicated by a slight stratification in the subsoil. The parent material consists of a course sandy loam with varying amounts of gravel. Stones and boulders are less frequent than in the Parry soils.

Two soil series have been mapped in this association, the Becaguimec series and the Snyder series, which form a natural land pattern. The former is found on the smoothly undulating, well drained land on which the modified till is fairly deep, while the latter is poorly drained and occupies broad flats and depressional areas which have a high water-table. Both of these series are typical podsol soils and are probably the most severely leached soils in the area.

(*a*) *Well Drained Soils*

BECAGUIMEC SERIES

The soils of the Becaguimec series occupy approximately 5,500 acres in the surveyed area. The topography is generally smooth and varies from level to gently rolling. Stones are small and not very numerous, although occasional boulders of sandstone or conglomerate may be found. The modified and slightly sorted till is usually over 4 feet in depth, although occasionally it is less than 3 feet deep. The surface drainage is good, and the internal drainage is very rapid to excessive due to the coarse texture and open porous condition of the soil. Under natural conditions the dominant vegetation consists of softwoods, of which spruce, fir, and jackpine are the main species. White birch and poplar are also found, but they are less extensive.

Only one soil type, the Becaguimec coarse sandy loam, has been established in this series. It is very light in texture and contains close to 80 per cent of sand. The cultivated surface soil is a light brown to greyish brown sandy loam, occasionally with a slightly developed granular structure, but more often single grained. It is a very open and friable soil and contains very little organic matter. Under virgin conditions the soil has a well-developed leached layer under the forest leaf mat, which is in turn underlain by a reddish brown coarse sandy loam. A more detailed description of a typical undisturbed profile of a Becaguimec coarse sandy loam is given below:—

Horizon	Depth	*Description*
A_0	0 – 2″	Dark brown to black layer of leaves and semi-decomposed organic matter. pH 4·2.
A_2	2″– 6″	Light ash grey coarse sandy loam to loamy sand, structureless with a few small stones. pH 4·2.
B_1	6″–14″	Light reddish brown to orange red, coarse sandy loam, structureless, with a small amount of gravel, few stones. pH 4·6.
B_2	14″–24″	Light reddish to yellowish brown, loamy sand, structureless, porous, containing small amounts of water-rounded gravel and sub-angular stones. pH 5·0.
C	24″–	Reddish brown loamy sand, with a brick red tinge, structureless, open, with some water, rounded gravel and stones. pH 5·2.

Agriculture.—A considerable percentage of the Becaguimec coarse sandy loam is covered with woods, which consist mainly of small second and later growth. The cultivated fields are usually small in size and are located near the main roads. The main crops grown on this soil are hay, oats, buckwheat, potatoes, and pasture, but the yields are ordinarily not very high. Old hay and pasture fields often have a very thin, weedy cover and tend to revert to bush. The soil is very droughty and the yields depend to a large extent on the amount and distribution of precipitation during the growing season. The natural fertility of the soil is comparatively low due to its acidity, lack of organic matter, lime, and other fertilizer ingredients. Great responses in crop yields can be obtained by building up the soil partly by the use of lime, manure, and fertilizers, and partly by the ploughing down of good aftermaths.

(*b*) *Ill Drained Soils*

SNYDER SERIES

The soils of the Snyder series cover approximately 6,400 acres in the surveyed area and are found in close association with the Becaguimec soils, occupying level and depressional areas. The parent material is similar to that of the Becaguimec soils and consists of coarse, partly sorted weathering products of the Carboniferous red sandstone and conglomerate. These soils have no surface run-off, but often receive drainage waters from higher land. They have a high water-table, which indicates the presence of a compacted and more impervious material at greater depth. In some cases, unweathered till has been found at about 3 feet below the surface. Under natural conditions these soils are covered with a shrubby growth of alder, poplar, black spruce, and cedar.

The Snyder sandy loam is the only soil type established in this series. In cleared fields the soil is dark brown to black and has a friable, granular structure, if the water-table is not too close to the surface. Light grey streaks often occur in the surface soil due to mixing with the grey subsurface soil. A detailed description of an undisturbed virgin profile of the Snyder sandy loam is given below:—

Horizon	Depth	*Description*
A_0	0 – 3″	A black mat of leaves and decomposing organic matter. pH 4·0.
A_1	3″– 6″	Black silty to sandy loam consisting of a mixture of mineral soil and finely divided organic matter, often with the appearance of a coarse granular structure. pH 4·2.
A_2	6″– 9″	Ash-grey sandy loam, structureless or with slight lamination. pH. 4·2.
B	9″–16″	Reddish brown sandy loam, mottled, structureless, with small amounts of gravel and stones. pH 4·6.
C	16″–	Dark to light brown sandy loam, with purplish tinge, structureless, but firm due to close packing of fine and coarse material. Water appears to move freely through this horizon. pH 5·2.

Agriculture.—Most of the Snyder sandy loam is covered with bush, and very little of the land is cultivated. The cleared and improved fields are used mainly for permanent pastures, which are very seldom ploughed or cultivated. If the groundwater is not too close to the surface, such pastures often have a fairly good stand of coarse grasses and occasional patches of almost solid stands of wild white clover. In the wetter places sedges usually dominate. The Snyder sandy loam is not suited for the production of most agricultural crops. Extensive improvements in drainage conditions are in most cases uneconomical because of the low natural fertility, the acid reaction, and the coarse open texture of the soil, and due to the presence of the high water-table.

V. Soils developed from grey loam to clay loam till, which has been derived mainly from granitic rocks of Devonian Age

Pinder Soils

The Pinder soils are located in the southeast section of the surveyed area, in the vicinity of Campbell Settlement, where approximately 2,550 acres of Pinder loam have been mapped. The topography of these soils varies from strongly undulating to hilly and presents a rugged appearance. The parent material of the Pinder soils consists of a grey to yellowish grey or greyish brown loam to clay loam till, which appears to have derived largely from the underlying Devonian granitic rocks. Many granitic stones and boulders are found in the till and on the surface of the soil. In some cases the mantle of till covering the bed-rock is not very thick and in such instances strongly weathered, very

crumbly granite is found close to the surface (at 2 feet or deeper), which, when disturbed, forms a very sharp, light coloured, glistening gravel and coarse sand.

The surface drainage is usually good to excessive, due to the strongly sloping nature of the relief. Permeability of the soil results in good internal drainage. There are no ill-drained soils on this parent material in the surveyed area, as there are no extensive smooth areas, and the run-off waters are carried away by numerous small intermittent streams. As a result only one soil series, the Pinder series, has been established on this parent material. However, large areas adjacent to the Pinder soils, in which the parent material is of similar origin and nature, have been mapped as "rough and stony land". This land is considered to be too rugged and stony for agricultural purposes and has for that reason been grouped in a separate land class together with other lands which have approximately the same agricultural possibilities. The rough and stony land is discussed in a separate section elsewhere in this report. The vegetation on this parent material is predominantly coniferous, consisting mainly of spruce and fir with a smaller percentage of hardwoods, chiefly maple and beach.

The soils of the Pinder series do not vary appreciably in texture and the Pinder loam is the only soil type which has been established. Under cultivated conditions the Pinder loam has a greyish brown to brown surface soil with a fair supply of organic matter and a moderately well developed granular structure. The subsoil has a deep brown colour and is very friable. Under natural conditions the soil has a grey leached subsurface layer, which is characteristic of the podsol soils of this region. A detailed description of a typical profile of the Pinder loam is given below:—

Horizon	Depth	*Description*
A_0	0 – ½″	Dark brown mat of partly decomposed coniferous and deciduous foliage. pH 4·2.
A_1	½″– 3 ″	Dark brown to black heavy loam, high in organic matter, with granular structure, friable. pH 4·95.
A_2	3 ″– 6 ″	Greyish white heavy loam, of variable thickness, structureless, friable. pH 4·8.
B_1	6 ″–18 ″	Rusty brown loam, structureless, friable with some granitic stones. pH 5·0.
B_2	18 ″–26 ″	Yellowish brown loam with faint granular to coarse nutty structure, open and friable but becoming firm with depth. pH 5·65.
C_1	26 ″–32 ″	Yellowish grey loam, structureless, hard and compact, with some coarse angular sand and fine gravel. pH 5·95.
C_2	32 ″–	Yellowish grey clay loam, structureless and compact, with much coarse angular sand and quartz gravel. pH 6·0.

Agriculture.—About one-half of the soil mapped as Pinder loam is under cultivation and is used mainly for mixed farming purposes. On the smoother land, where the loss of water by run-off is not so great, and where the soil has an opportunity to absorb sufficient moisture during the growing season, good crops of hay and grain may be obtained. On the steeper slopes where it is more difficult to retain sufficient moisture in the soil due to the rapid run-off and as a result of seasonal droughts, the crops are usually less satisfactory. Erosion also presents a problem on the steeper slopes of the Pinder loam and should be guarded against by suitable management practices, such as contour cultivation, rotations, and strip cropping. Many of the steeper slopes can be used to best advantage by devoting them to permanent pastures or returning them to forest.

The natural fertility of the Pinder loam is considerably higher than that of the Parry or the Becaguimec soils, which have been discussed earlier. However, the crop yields can be greatly increased by the use of lime, manure, and fertilizers.

Soils developed on Water-Worked, Stratified Parent Materials

The group of soils described under the above heading is located chiefly along the banks of the St. John river and some of its tributaries, and they occupy about 28,000 acres, or approximately 5·5 per cent of the surveyed area. The land on which these soils are found rises in terraces from the valley floor to the upland on either side. Its topography varies from level and gently undulating on the valley floor to fairly steep slopes where it rises up to the terraces. Occasionally, this uniformity of the pattern is broken by small knolls, which may be kames, eskers, or the remains of terraces left by the denudation of beds once surrounding them, of which they once formed a part.

The parent materials of this group of soils are of composite geological origin and are of a heterogeneous nature. These materials have been transported by water, sorted to various degrees, and deposited in layers of varying thickness and textures. In this respect they differ from the parent materials of the soils discussed previously, and these differences are expressed in the appearance and in the characteristics of the soils.

The soils of this group have formed under climatic conditions which favour leaching, but the extent to which the podsolic characteristics have developed in the soil varies greatly, depending on differences between the parent materials and the length of time that has elapsed since their deposition. Three soil associations have been established on the basis of differences in the parent materials.

I. Soils developed on gravelly outwash, kames, and eskers

Gagetown Series

These soils, which have an extent of approximately 3,850 acres, are found on small, low ridges or knolls in or near the valleys of the St. John river and its larger tributaries. The parent material consists of layers of water-worked sand and gravel, the geological origin of which is difficult to determine. The layers vary in thickness and also in the grain sizes and in the relative amounts of sand and gravel which they contain. The total depth of the gravel varies from 3 or 4 feet to 20 feet or more, and it is underlain by glacial till or bed-rock. Numerous small, rounded stones are found on the surface and in the profile of the Gagetown soils, and occasionally larger boulders are also found. On the uncultivated land the vegetation usually consists of a scanty growth of white birch, poplar and some spruce.

The surface drainage of the soils on this gravelly parent material is good and the internal drainage is very rapid, due to the coarse texture and the porous nature of the soil. Only one series has been mapped on this parent material.

The Gagetown series has already been described in the soil survey report of the Fredericton-Gagetown area. The till underlying the gravelly material differs in the two areas; this, however, has very little effect on the soils. Generally the reaction of the Gagetown soils is slightly higher in the Woodstock area than in the Fredericton-Gagetown district. Although the soils of the Gagetown series are typical podsols, exhibiting a grey leached subsurface horizon, this layer is usually not so deep in the Woodstock area as in the Fredericton-Gagetown area.

The Gagetown soils in the Woodstock area show noticeable variations in the size and the relative amounts of sand and gravel between profile as well as between individual horizons, with attendant variations in their soil characteristics and their capacity for agricultural use. The gravel content varies from 30 to 50 per cent, and the amount of sand varies from 40 to 70 per cent of the total weight, leaving about 20 per cent or less of silt and clay. Two soil types, the gravelly loam and the sandy gravelly loam, of the Gagetown series, have

been mapped in the Woodstock area. The essential difference between these soils is the larger percentage of sand, and the smaller proportion of gravel in the latter type, especially in the surface layers.

The cultivated surface soils of the Gagetown series are light brown to greyish brown gravelly to coarse sandy loams. They are low in organic matter and are structureless. A detailed description of a typical profile of an undisturbed wooded Gagetown sandy gravelly loam is given below:

Horizon	Depth	*Description*
A_0	0 – 1″	Undecomposed foliage, moss, and roots.
A_1	1″– 2″	Black semi-decomposed organic matter mixed with sand and gravel. Often absent. pH 5·4.
A_2	2″– 4″	Light grey to white coarse sandy to gravelly loam, friable and structureless. Often extends to greater depth in pockets. pH 5·4.
B_1	4″–16″	Bright reddish brown, coarse sandy gravelly loam, structureless, open; the gravel is water-rounded and of fairly uniform size. pH 6·2.
B_2	16″–28″	Light reddish brown coarse sandy to gravelly loam; structureless, open and friable. pH 6·2.
C	28″–	Grey to greyish brown sand and gravel, plainly stratified into layers of finer and coarser water-rounded material. pH 5·9.

Agriculture.—Due to their favourable location near the larger rivers and the main roads, which was of great importance in the early days of settlement, the Gagetown soils have been extensively cleared and improved. A variety of crops are grown with varying degrees of success, but the productivity of these soils is generally low. They are very droughty by reason of the porous nature of the soil and they are lacking in fertility. As a rule grain crops are short-strawed and do not fill out properly, while hay and clover crops are usually very light. In old hay meadows and pastures the better grasses usually give way to the more persistent poverty grass, paint brush, sorrel, and ox-eye daisy. During the dryer summer months, the pastures turn brown and dry up quickly, providing very little grazing. Potato yields are usually much lower than on the adjacent Caribou and Carleton soils, but strawberries are sometimes grown quite successfully.

The fertility of the Gagetown soils can be greatly improved by the addition of organic matter in the form of barnyard manure or green manure and by the use of commercial fertilizers and lime. The crop responses after treatment are usually very striking during the first year, but the beneficial effect wears off quickly in succeeding seasons. The organic matter decomposes rapidly, and the plant nutrients wash out easily through the porous subsoil.

The Gagetown soils become dry and warm up early in the spring and are therefore best suited for early crops, such as strawberries and early potatoes. When well managed they also produce early pasture before most of the adjacent land is dry and fit for grazing. They are not adapted to late crops.

II. Soils developed on sandy deposits along river terraces

Riverbank—Oromocto Association

This association covers approximtely 20,500 acres, and is found in comparatively narrow strips on the terraces and low uplands along the valleys of the St. John river and its larger tributaries. The soils of this association have developed on sandy, slightly stratified deposits which occasionally contain thin layers of gravel or silt. These materials were deposited from fairly rapid flowing streams during and after the last glaciation at higher levels than exist now even during floods and spring freshets. The waters discharged their suspended

materials in layers, which may vary with respect to thickness and size of particles. The sandy material is underlain by fairly compacted till at a depth varying from 2 feet to about 10 feet; the most common depth is about 4 feet.

The drainage of these sandy soils is variable and depends on the relief and on the depth and nature of the subsoil. Hence both well drained and poorly drained soils have been mapped on this parent material.

(*a*) *Well Drained Soils*

RIVERBANK SERIES

The Riverbank series is the well-drained member of the Riverbank-Oromocto association. It covers about 18,500 acres in the Woodstock area and is found mainly on the slopes and terraces along the valleys of the St. John river and some of its tributaries. The parent material, as already described, consists of layers of coarse and fine sandy loam, which are underlain by till. The underlying till has been derived mainly from Silurian shales and slates and often contains free carbonates of lime. The Riverbank soils in the Woodstock area differ in this respect from those of the Fredericton-Gagetown area. In the latter district the underlying till has been largely derived from grey Carboniferous sandstone. The nature of the till, however, has very little effect on the overlying soil, and there is no appreciable difference between the Riverbank soils in the two areas. The topography of the Riverbank soils varies from gently undulating on the top of the terraces and on the bottom of the valleys to steeply sloping along the banks of the valleys and terraces. The natural vegetation on these soils consists largely of white birch, poplar and spruce.

Two soil types, the sandy loam and the fine sandy loam, and a gravelly phase of either type have been mapped in the Riverbank series. The cultivated soil of the sandy loam is light brown, loose and friable, and has practically no structure, while the fine sandy loam is usually a little darker in colour and has a fairly well developed granular structure. The main difference between these two types, however, is found in the texture of the surface soil. The gravelly phases of these types contain somewhat more gravel, which is especially noticeable on the surface after a rainstorm. The amount of gravel in the soil, however, is not sufficient to alter the general morphological characteristics of the soil appreciably. The subsoil of the Riverbank soils is loose and friable, and changes from reddish brown to greyish brown and grey with depth. Stones and boulders are seldom found on the surface and in the profile, but where they do occur, the soil has been mapped as a stony phase. In the uncultivated state the profiles of the Riverbank series have the appearance of a well developed podsol soil with a typical, grey leached horizon under the leaf mat. The grey, leached horizon is underlain by a reddish brown sandy loam. A more detailed description of a typical, virgin sandy loam, which is the most widely distributed type, is given below.

Horizon	Depth	*Description*
A_0	0 – ½″	Brown semi- to undecomposed mat of leaves of spruce and poplar.
A_1	1″– 2½″	Dark brown to black loam, high in organic matter, with granular structure, friable. pH 5·0.
A_2	2½″– 5″	Light grey sandy loam, with slightly developed platy structure, friable; thickness varies from a trace to 3″ or 4″. pH 4·6.
B_1	5″–15″	Reddish brown light sandy loam, structureless, open and friable, and free from stones. pH 5·3.
B_2	15″–28″	Yellowish brown loamy sand, structureless, friable. pH 6·0.
C_1	28″–40″	Grey sand and loamy sand, alternating with thin layers of brown silty loam. The sandy layers are open and friable, while the silty loam is rather compact. pH 6·3.
C_2	40″–	Grey, coarse, water-rounded sand and gravel. The depth at which this horizon is encountered varies from 3 to 4 feet. At 4 feet there is usually slight effervescence with HCl, at 10 feet strong reaction.

Agriculture.—The Riverbank soils are largely under cultivation and are used for potato growing as well as for general farming purposes. Due to their light texture and general relief these soils drain quickly and are ready for cultivation and seeding early in the spring. Being virtually free from stones in the surface layers they are easy to cultivate, and their open consistency makes good root development possible, which to some degree offsets the disadvantages of the general dryness of the soil. When properly fertilized, limed, and manured or otherwise supplied with organic matter, the Riverbank soils produce excellent crops of grain, hay and potatoes. On the other hand their productivity deteriorates very quickly, if they are neglected. In a light soil such as the Riverbank the preservation of the topsoil is of great importance from a fertility standpoint. Unfortunately the Riverbank soils are often on fairly steep slopes and show a strong tendency to erode. A high percentage of gravel in the surface soil which does not persist in the lower horizons is generally a sign that erosion is under way. Even though gullies may not be formed, large amounts of soil containing the productive ingredients of the land are removed in the form of a thin sheet from whole fields after each rainfall. The prevalent method of cultivating up and down hill should be abandoned and replaced by a rotation of narrow strips of alternating close-growing and row-crops planted across the slope.

The incorporation of organic matter and liming are the most important soil building measures on the Riverbank soils. By gradual addition of two or three tons of ground limestone per acre a good stand of hay and clover may be obtained, and if the hay is cut early there will be a good aftermath, which should be ploughed under in order to enrich the store of organic matter. Fields that are used for potato growing should receive less lime, but even the addition of one-half ton of lime would aid the growth of clover considerably.

Special crops such as strawberries, raspberries, and other small fruits usually grow well on soils of the Riverbank series, which also have the main characteristics of good orchard soils, namely, good drainage and a deep, open subsoil for root development.

(*b*) *Ill Drained Soils*

OROMOCTO SERIES

The Oromocto series covers approximately 2,000 acres in the Woodstock area. It occurs in close association with the Riverbank soils and is found in slight depressions on the bottom of the river valleys and on the terraces. The parent material of this soil series is similar to that of the Riverbank soils, consisting of layers of water-deposited coarse and fine sand which alternate with thin layers of compacted silt in the subsoil. The water-deposited material is underlain by fairly compacted till at about 4 feet. Due to the depressional topography and the compacted subsoil, the Oromocto soils are poorly drained and often have a high water-table. The morphological characteristics of this soil differ significantly from those of the Riverbank soil series, although both have a grey leached A_2 horizon, typical of podsol soils. The Oromocto soils have considerably more organic matter on the surface than the Riverbank soils and have a mottled yellowish brown to greyish subsoil. The natural vegetation on the unimproved land of this series consists of a shrubby growth of poplar, alder, cedar, and spruce.

Two soil types have been mapped in the Oromocto series, the sandy loam and the fine sandy loam. The cultivated surface soil of the Oromocto series consists of a dark brown to black sandy to fine sandy loam, fairly rich in organic matter and with a well developed granular structure. A more detailed description of a representative undisturbed Oromocto sandy loam follows.

Horizon	Depth	*Description*
A_0	0 – 2″	Black layer of semi-decomposed organic matter. pH 4·5.
A_1	2″– 5″	Black silty loam, consisting of finely divided mineral soil and well decomposed organic matter. Granular structure. pH 5·0.
A_2	5″– 8″	Greyish fine sandy loam. Structure not apparent. Three inches is an average thickness; very often this layer is thinner, and in other cases it forms deeper pockets. pH 4·8.
B_1	8″–14″	Yellowish brown sandy loam, mottled, with granular structure, and containing a little gravel. pH 5·4.
B_2	14″–20″	Yellowish grey sandy loam, mottled, structureless, and somewhat gravelly. pH 6·0.
C	20″–	Light brown, compact layer of silt and clay with some sand and gravel embedded in it. This layer usually restricts the penetration of water. This is followed at 28″ by greyish brown, water-rounded, stratified sand and gravel. pH 5·8 – 6·0.

Agriculture.—The Oromocto soils are not well suited for agricultural development and the largest percentage of the land is unimproved and in forest. Some of the land that has been cleared from time to time has reverted to bush within a comparatively short period.

Most of the cleared land is in permanent pasture. The pasture herbage on these soils is usually not of very high quality, and a considerable proportion of the vegetation consists of carex, juncus, and bent grasses. Due to the wet and soggy soil conditions it is difficult to establish a good sod, as the cattle will puncture it, unless they are kept off during the wet periods. The Oromocto soil is cultivated only where strips of it extend into otherwise well drained positions. Hay crops do very well in dry years, but in wet years and in wetter positions the quality and the yields of hay are poor. Grain crops grow satisfactorily only on the better drained positions where drainage conditions have been improved. Artificial drainage will greatly improve this land, but local factors should be weighed, before such projects are undertaken.

III. Immature Soils on Recently Deposited Bottom Land

Interval Association

The first bottom soils cover about 3,500 acres in the Woodstock area and are found scattered along the valley floors of the St. John river and some of its tributaries. These soils have a level to gently undulating topography, and their elevations are only slightly above the summer level of the rivers. The parent materials of these soils consist of stratified deposits of silt, clay, and fine sand, but they are free from stones and generally from gravel. These deposits represent a part of the finer materials which have been removed from the upland soils by erosion, and they have been settled out of the flood waters to form river flats and islands in the river. The process of deposition is still taking place, whenever the bottom lands become inundated after the spring thaws or after heavy rains.

Due to the comparatively recent deposition of the parent material, the soils have not been acted upon by climatic agencies long enough to form profile characteristics typical of the podsol soils on the surrounding upland. The soils of the Interval association have no marked profile horizons, although there is a slight gradual change in colour from the surface downward. Such soils are frequently referred to as "azonal" soils.

The natural vegetation of this soil association is distinctly different from that of the upland soils. The elm, which often grows to imposing height, is typical of the bottom land soils, and large individual trees are usually found along fences and along the river banks. The more poorly drained sites on this soil are usually covered with a dense growth of alder and willow or have a luxurious growth of marsh and meadow grasses.

During the spring floods the soils of the Interval association are either covered with water or are saturated and have a high water-table; but as soon as the water level drops in the river, the surplus moisture rapidly seeps away. The soils then dry up very rapidly and retain none of the undesirable characteristics of poorly drained soils. However, in some of the depressional areas, especially those farthest away from the river, which usually receive some seepage water from the adjoining upland, the internal soil drainage remains poor during the better part of the growing season.

The better drained soils of this association have been mapped as the Interval series, while the more poorly drained sites have been mapped separately. Due to the limited occurrence of the latter, they have not been named as a new series, but are usually simply referred to as a poorly drained phase of the Interval series or as the ill drained associate of the Interval association. They are shown on the map by the addition of the suffix "i" to the symbol of the respective type of the Interval series.

INTERVAL SERIES

The surface soil of the Interval series consists of a light chocolate brown silty loam to fine sandy loam. It has a well developed, fine granular structure, and it remains moist and mellow throughout most of the season. The colour fades gradually with depth to a dark grey or brownish grey at about 3 feet. The darker colour of the surface soil is due to the presence of a greater amount of organic matter. Occasionally a slight amount of gravel may be found in the upper few inches of the profile, but otherwise the latter is free from coarse material. The reaction of both the topsoil and subsoil ranges from pH 6·0 to pH 7·0.

The Interval series contains two types, the silty loam and the very fine sandy loam. The silty loam has an average composition of 25 per cent very fine sand, 50 per cent silt, and 25 per cent clay. These ratios remain quite uniform to a depth of at least 30 inches. The very fine sandy loam contains about 45 to 55 per cent of fine sand and very fine sand, 30 to 40 per cent silt, and the remainder is clay. A more detailed description of a typical profile of the very fine sandy loam is given below.

Depth	*Description*
0 – 6″	Chocolate brown very fine sandy loam, containing a fair amount of organic matter. This layer has a fine granular structure and is friable and mellow. pH 6·8.
6″–24″	Light brown very fine sandy loam, with fine granular structure and friable consistency. pH 7·2.
24″–36″	Greyish brown fine sandy loam, with less evidence of structure, but open and friable. pH 6·8.
36″–	Dark grey fine sandy loam, apparently structureless, but open and friable. pH 6·8.

The ill drained phases of the respective soil types differ somewhat in appearance from the typical Interval soils described above. They have a deeper and darker surface soil containing more organic matter. The subsoil is distinctly mottled and cold and the structure is not well developed.

Agriculture.—The Interval soils occupy only 0·7 per cent of the total map area, but they are cleared practically in their full extent. Their distribution is too small to make them economically important in the district, but they are highly valued by the individual owner, as they are very fertile and are easy to work, being free from stones and having a level surface. Hay, grain, potatoes, market garden crops, strawberries, and other small fruits are among the crops which give good yields on Interval soils. The main factor which

may detract from the value of these soils in the production of early or long-season crops is the fact that they often become flooded in the spring and remain wet till late in the planting season.

The Interval soils are probably the most fertile soils of the entire area and their fertility is renewed by every fresh deposit that they receive during inundations. Nevertheless, these soils do respond to the use of commercial fertilizers and manure, especially on higher fields which are seldom flooded, or which lie above the present high water mark.

The ill drained Interval soils are in most cases covered with shrubs and bushes, as they are too wet for farming purposes. Artificial drainage would greatly improve these soils if it were feasible; but due to their low positions they can in many cases not be drained satisfactorily.

Organic Soils

Organic soils have been mapped in various localities in the Woodstock district, but individual areas do not assume large proportion in any one place. They are most extensive in the southwestern part of the district, near the Maine border. They cover a total of about 11,000 acres, on nearly level topography. The organic soils owe their origin to the accumulation of vegetable matter in shallow water, and the process is still going on in many lakes and ponds. The depth of organic matter varies considerably. In many cases it is 12 feet deep or more, while in other cases it is often difficult to distinguish between organic soils and the very poorly drained upland soils. Only those areas with a covering of organic matter at least 12 inches deep or more are mapped as organic soils. The latter are underlain by a bluish grey, badly mottled "glei layer". The organic soils are classed in two groups, peat and muck.

PEAT

Peat has only a small distribution. It is a brown, fibrous material consisting of the dead remains of moss and sedges, which, as a rule, are so poorly decomposed that the original plant structure can still be seen. The peat is water-logged, and has a very acid reaction. The vegetation consists of scattered, stunted black spruce and birch, laurel, Labrador tea, cranberries, blueberries, cotton grass, sedges and sphagnum moss. The peat soils are not suited for farming purposes.

MUCK

The muck is more extensive than the peat. The surface soil consists of a black, amorphous mass of organic matter in an advanced stage of decomposition. The subsoil consists of semi-decomposed to poorly decomposed organic remains. During the summer the upper part, or the first 6 or 12 inches, is fairly dry and assumes the semblance of a granular structure, while the lower part remains wet and fibrous. The vegetation consists of stunted cedar, tamarack, black spruce, and white birch, with an undergrowth of moss and coarse grasses.

Agriculture.—Most of the muck soils have not been cleared of their natural vegetation, although some of the better drained areas have been improved and are used for permanent pastures. The pastures usually have a poor sod, and they are not very productive. Muck soils have been cultivated only in such places where narrow strips extend into cultivated fields. Such muck areas are best suited for hay as the grain crops usually lodge and fail to fill out and mature properly. A limited area of the muck soils could probably be used to advantage for the production of certain garden crops. The muck soils have an

abundant supply of organic matter and nitrogen, but they are lacking in mineral plant nutrients, especially in potash. This deficiency must be corrected for successful crop production on these soils.

Rough and Stony Land

Approximately 44,000 acres have been mapped in the Woodstock area as "Rough and Stony" land. This land class does not consist of any particular soil type, but is characterized by its physical handicaps to cultivation, such as rugged topography, extreme stoniness, and frequent outcrops of bed-rock. It is found on soil materials related to the Silurian and Pre-Silurian shales and slates, the Carboniferous sandstones and conglomerates and the Devonian granites. The soils that are included in the "Rough and Stony" land may, therefore, belong to any of the soil associations which have formed from these respective parent materials. It was thought unnecessary to separate and map the individual soils as the uses to which such land can be put are governed almost entirely by external factors. Modern farm machinery cannot be used on the "Rough and Stony" land, and as a result most of the land is in forest. Occasionally small patches, only a few acres in extent, of smoother land, which could be cultivated, are included with the "Rough and Stony" land, but such smooth areas are usually isolated by Rough land so that they are of no agricultural importance.

Some of the "Rough and Stony" land has been cleared and improved from time to time, but a large percentage of such land has reverted to forest, while the remainder is used for permanent pastures. Under some circumstances such use of the land may be profitable, especially if it is adjacent to good farm land, on which other feed can be grown. Practically all improvements on the pastures, such as applying lime and fertilizer and cutting down small shrubs and bushes, have to be made by hand. Generally the "Rough and Stony" land is best suited for forest, which helps to conserve moisture and prevents or retards soil erosion.

The Rating and Adaptability of the Soils for Agricultural Crops

The productivity and the adaptability of each individual soil have been discussed in the preceding pages. In table 6 the suitability of each soil for the main agricultural crops grown in this area has been summarized. The soils have been rated as excellent, good, fair, poor, very poor, and unsuitable for the following crops: oats, barley, wheat, buckwheat, potatoes, hay (both clover and grasses), pasture and small fruits. The rating has been estimated on the basis of crop observations and on information obtained from the farmers. Due to the lack of sufficient yield data the rating cannot be used for comparing the estimated productive capacity of the listed soils with that of soils in other provinces. In other words, a soil which has been rated as a good oat soil in this area may only be considered as a fair oat soil in other parts of Canada, etc. The rating serves as a means of comparison between the soils of the surveyed area and is a temporary approximation which may be useful until more accurate data can be obtained.

The rating has been based on the assumption that good farming practices have been used, and that the soil has not been seriously depleted. The better soil management practices have been briefly outlined in the discussions of the individual soils. In estimating the suitability of the soils for clover it has been assumed that some lime has been used and that the organic-matter content is not too low. Unfortunately the land has in many cases not been managed in such a manner as to conserve the productivity of the soil. As a result, the present fertility of the soil is frequently low.

TABLE 7—ESTIMATED SUITABILITY OF INDIVIDUAL SOIL TYPES FOR CERTAIN CROPS

Soil Type	Suitability for								
	Oats	Barley	Wheat	Buck-Wheat	Pota-toes	Hay			Small Fruits
						Clover	Grasses	Pasture	
Caribou heavy loam........	G	G	G	G	E	G	G-F	G-F	G
Caribou light loam.........	G	G	G	G	E	G	G-F	G-F	G
Caribou silty loam.........	G	G	G	G	E	G	G	G-F	G
Caribou shaly loam........	F	G-F	G-F	G-F	G-F	G-F	F	F-P	G
Carleton clay loam.........	E	E	G	G	F	E	G	G	F
Carleton loam..............	G	G	G	G	G-F	G	G-F	G-F	G
Washburn clay.............	F	P	P	F	VP	F	G	G	P
Washburn clay loam........	F-P	P	P	F-P	VP	F	G	G	P
Kingsclear clay loam.......	G	G	F	G	F	G	G	G	G-F
Nackawic clay loam........	P	P	VP	F-P	VP	F	F	G-F	P
Parry sandy loam..........	F	F	F	F	G-F	G-F	G-F	G-F	G-F
Midway sandy loam........	P	VP	VP	F-P	VP	P	F-P	F	P
Becaguimec sandy loam....	F-P	P	P	F	F	F-P	F-P	F	G-F
Snyder sandy loam.........	P	VP	VP	P	VP	P	F-P	F-P	P
Pinder loam................	G-F	F	F-P	G-F	F	F	G-F	G-F	F
Gagetown gravelly loam....	F-P	P	P	F-P	F	F-P	P	P	F
Gagetown sandy gravelly loam....................	F-P	P	P	F	F	F-P	P	P-F	F
Riverbank sandy loam.....	G-F	G-F	F	G-F	G	F	F	G	G
Riverbank fine sandy loam.	G-F	G-F	F	G-F	G	F	G-F	G	G
Oromocto sandy loam......	P	VP	VP	P	P	P	F	F-P	P
Oromocto fine sandy loam..	P	VP	VP	P	P	P	F	F-P	P
Interval silty loam..........	E	G	G	G	G	G	E	E-G	E-G
Interval very fine sandy loam....................	E	G	G	G	G	G	E	E-G	E-G
Muck.....................	P	VP	VP	F-P	....	VP	F-P	P	G-F
Peat......................	......	....	....	....	....	....	....	....	....
Rough and stony land......	......	....	....	....	....	....	....	F-P	....

Symbols: E—Excellent, G—Good, F—Fair, P—Poor, VP—Very Poor, ——Unsuitable

The yields of some crops are much less than what would be expected from the soil rating. On the other hand, in some instances soils which have been rated as poor for certain crops have been greatly improved by artificial means, and they produce yields far in excess of the given rating. The suitability of a soil for certain crops may in some cases also vary from the given rating due to physical handicaps of the land, such as extremely steep slopes, excessive stoniness, etc.

Table 7 shows that the different soils vary greatly in their suitability for the production of any one of the main crops, and that a particular soil is not equally well adapted for the different crops. An example of this is seen in the Caribou loam and the Carleton clay loam. The former has been rated as excellent for potatoes and good for grain and clover, while the latter has been rated as excellent for grain and clover, but only fair for potatoes. The Washburn soils, on the other hand, have been considered poor for grain, very poor for potatoes, and fair for clover, but good for hay and for pasture. This indicates that the kind of crop that can be grown and the type of farming that can be practised to best advantage depend to a large extent on the kinds of soil that are present on the farm.

The variation in the adaptability of the different crops to the soils shows clearly the difficulty of giving a particular soil one general rating for agricultural purposes. However, an examination of table 7 shows that for some practical purposes the soils can be grouped according to their general fertility

and adaptability; such a grouping, which differs both in purpose and character from the soil classification scheme which was outlined earlier, may be arranged as follows:—

1. *Interval Series.*—The well drained soils of this series are probably the most productive soil in the map area, and they are well suited for all the crops under consideration.

2. *Caribou, Carleton, and Kingsclear series.*—The soils of these series are fairly productive and a wide variety of crops can be grown on them with a fairly good degree of success. Some differences in productivity exist between the individual soils of this group. Thus, the Caribou shaly loam is generally less productive than the other types. The other Caribou loam soils have been rated as excellent potato soils, while the Kingsclear clay loam and the Carleton clay loam are only fair potato soils, but the latter is an excellent soil for grain and hay.

3. *Riverbank, Pinder and Parry Series.*—The natural fertility of these soils is usually considerably less than that of the above group. Because of their ease of handling and their favourable location, the Riverbank soils are usually more extensively and more intensively farmed than the other two series. As a result, a larger percentage of the Riverbank soils are in a fairly good state of fertility, while more soils of the other two series have been run-down and depleted. The Riverbank soils also seem to be naturally somewhat better suited for potatoes, pastures and small fruits than the soils of the other two series.

4. *Becaguimec and Gagetown Series.*—These soils are comparatively unfertile and droughty. Their best use seems to be for early crops.

5. *Washburn and Nackawic Series.*—These poorly drained soils are comparatively fertile, but their suitability for the production of most crops is limited by the poor drainage conditions.

6. *Midway, Snyder and Oromocto Series.*—The utilization of the soils of this group for most crops is limited by poor drainage conditions and by the low natural fertility.

7. *Muck Soil.*—Most of the muck soil in this area is too poorly drained to be of great agricultural value.

8. *Peat and Swamp.*—Unsuitable for agricultural purposes.

9. *Rough and Stony Land.*—This land is too rough for ordinary farm practices, but can be used for pastures.

The above grouping of the soils is quite simple and has some merit as a basis for comparing the productivity of the different soils. Actually the natural soil patterns do not consist of such combinations as have been indicated in the above grouping. Only in a very limited number of cases will a Caribou and a Kingsclear soil, or a Riverbank and a Pinder soil, or a Washburn and a Nackawic soil, and so on, occur together on the same farm. An individual farmer will more likely be concerned on his farm with a Caribou and Washburn soil, or with a Kingsclear and Nackawic soil, or a Riverbank and Oromocto soil, and so on, as shown in the scheme of classification earlier in the report. The natural distribution pattern of soils in the Woodstock area is usually such that soils of contrasting characteristics occur on a single farm. It is, therefore, advisable and profitable for a farmer to plan his crops and rotations in such a way that the different soils are devoted to those crops for which they are best suited.

REFERENCES

(1) Can. Geograph. Journal—Vol. XXI, No. 3, Sept. 1940, pp. 135-137.

(2) T. C. L. Ketchum. A short history of Carleton County, New Brunswick.

(3) Abraham Gesner. New Brunswick, with Notes for Emigrants. London, 1847.

(4) J. F. W. Johnston. Report on the Agricultural Capabilities of the Province of New Brunswick. Fredericton, 1850.

(5) Hugh Murray. History of British North America. Edinburgh, 1839.

(6) I. S. McArthur. An Economic Study of Potato Production in New Brunswick. (Dominion of Canada, Department of Agriculture, Technical Bulletin No. 8) 1937.

(7) P. C. Stobbe. Soil Survey of the Fredericton-Gagetown Area. (Dominion of Canada, Department of Agriculture, Technical Bulletin No. 30, 1940.)

APPENDIX

TABLE 7.—ACREAGES AND PERCENTAGE DISTRIBUTION OF SOIL TYPES IN THE WOODSTOCK MAP AREA

Series	Acres	% of Map Area
Caribou	141,500	28·3
Carleton	89,600	18·1
Washburn	140,500	28·1
Kingsclear	500	·1
Parry	3,500	·7
Becaguimec	5,500	1·1
Nackawic	350	·1
Midway	3,800	·8
Snyder	6,400	1·3
Pinder	2,500	·5
Gagetown	3,800	·8
Riverbank	18,500	3·6
Oromocto	1,900	·4
Interval	3,500	·7
Peat and muck	11,000	2·2
Rough and stony land	44,200	8·8
St. John river	6,100	1·2
Lakes and swamps	16,000	3·2
Total	499,200	100·0

CHEMICAL AND PHYSICAL ANALYSES OF REPRESENTATIVE SOIL SAMPLES

Horizon	Depth in Inches	Physical Composition: Sand	Silt	Total Clay	Fine Clay	Chemical Analyses (a): Moisture	Loss on Ignition	Lime (b) Requirement	pH	N2	P_2O_5	K_2O	S_iO_2	R_2O_3	CaO	MgO
		%	%	%	%	%	%	lb.		%	%	%	%	%	%	%
Caribou Clay Loam																
Cult. Surf....	0–6	35·0	35·4	29·6	22·6	2·83	10·53	7,060	5·45	·285	·339	1·38	64·42	19·67	·14	·53
A_0..........	0–2	....	....	....	....	8·42	80·54	84,720	3·61	1·133	·246	·31	17·24	2·82	·38	·21
A_2..........	2–4	30·6	43·8	25·6	16·4	1·23	3·67	14,105	4·09	·104	·126	·59	85·41	7·47	·13	·15
B_1..........	4–8	40·0	43·6	16·4	14·4	3·73	12·14	12,225	4·83	·218	·279	1·10	60·85	21·45	·31	1·01
B_2..........	8–12	38·4	36·4	25·2	16·4	3·03	9·67	8,782	4·93	·158	·243	1·52	61·20	22·89	·42	1·81
C..........	12–	33·4	27·6	39·0	31·6	·90	4·64	2,926	5·50	·059	·183	1·68	63·92	24·78	·34	1·30
Carleton Clay Loam																
Cult. Surf....	0–6	35·8	41	23·2	17·8	5·82	13·19	13,240	5·03	·344	·277	·88	63·48	21·01	·31	·99
A_0..........	0–2	....	....	....	......	18·53	80·41	64,036	4·10	1·526	·217	·24	15·28	4·63	·59	·41
A_2..........	2–5	30·8	41·4	27·8	24·8	1·55	4·42	11,535	4·42	·157	·069	1·14	83·35	10·57	·19	·57
B_1..........	5–12	35·6	47·8	16·6	13·8	8·63	15·78	17,910	5·15	·262	·263	1·30	56·53	25·89	·39	·95
B_2..........	12·18	26·8	58·6	14·6	11·8	2·89	7·23	6,371	5·41	·109	·113	·97	66·33	23·63	·41	1·30
B_3..........	18–23	32·8	48·2	19·0	14·6	1·53	4·90	6,044	5·65	·097	·094	·85	70·64	22·21	·44	1·13
C..........	23–	20·2	52·2	27·6	25·2	1·27	3·70	1,804	6·00	·051	·101	1·54	70·86	22·46	·48	1·01

Washburn Clay Loam

Cult. Surf....	0–6	28·6	40·4	31	22·6	3·09	13·97	2,065	6·88	·403	·555	1·58	62·04	18·64	1·13	1·32
A............	0–6	39·2	32·6	28·2	24·2	8·29	23·02	8,102	6·22	·568	·295	2·06	57·31	22·80	·96	1·12
B_1...........	6–11	36·6	35·0	28·4	22·2	1·90	4·68	3,098	6·65	·087	·147	1·84	69·36	23·41	·57	1·62
B_2...........	11–21	38·4	24·0	37·6	33·6	2·26	3·45	0	7·12	·052	·110	2·06	69·58	22·92	·82	1·44
C............	21–	34·0	30·2	35·8	31·2	1·30	3·55	0	8·12	·053	·115	2·02	68·21	22·26	1·07	1·60

Parry Sandy Loam

Cult. Surf....	0–6	47·0	34·6	18·4	13·2	2·98	10·83	11,190	4·98	·271	·147	1·43	64·49	18·74	·66	1·16
A............	0–4	47·6	33·8	18·6	16·1	5·22	15·88	8,973	5·30	·428	·139	1·57	61·03	16·15	·85	·56
B_1...........	4–15	52·6	35·8	11·6	10·1	6·70	11·36	10,143	5·40	·239	·351	1·56	60·04	28·75	·74	·89
B_2...........	15–22	64·8	20·4	14·8	13·0	3·31	6·41	9,298	5·37	·094	·135	2·02	62·73	30·13	·25	·75
C............	22–	67·6	17·4	15·0	13·1	2·59	5·08	7,398	5·64	·053	·114	2·20	64·79	24·68	·41	·70

Pinder Loam

Cult. Surf....	0–6	32·2	35·6	32·2	25·6	2·63	9·63	7,231	5·22	·264	·108	1·76	64·55	20·62	·69	1·10
A_1...........	0–1	43·0	39·8	17·2	14·0	3·18	17·01	15,155	4·95	·411	·078	1·35	68·57	11·79	·42	·38
A_2...........	1–3	32·8	40·0	27·2	21·6	1·60	3·75	12,400	4·77	·118	·052	1·82	79·32	12·88	·46	·35
B_1...........	3–15	46·0	40·2	13·8	12·4	3·88	9·50	8,266	4·98	·131	·165	2·17	61·44	25·48	·59	1·12
B_2...........	15–28	51·8	31·4	16·8	10·4	2·18	6·66	4,477	5·65	·103	·112	2·30	63·49	25·12	·44	1·22
C_1...........	28–36	43·8	40·4	15·8	10·8	·91	3·52	1,721	5·95	·043	·066	2·49	66·25	26·13	·76	·81
C_2...........	36–	83·2	15·8	1·0	·8	·83	2·71	860	5·98	·029	·102	2·75	67·78	23·72	·65	·42

CHEMICAL AND PHYSICAL ANALYSES OF REPRESENTATIVE SOIL SAMPLES

Physical Composition						Chemical Analyses (a)										
Horizon		Sand	Silt	Total Clay	Fine Clay	Moisture	Loss on Ignition	Lime (b) Require-ment	pH	N2	P_2O_5	K_2O	S_iO_2	R_2O_3	CaO	MgO
	Depth in Inches	%	%	%	%	%	%	lb.	%	%	%	%	%	%	%	%
RIVERBANK SANDY LOAM																
Cult. Surf....	0–6	61·9	24·2	13·9	11·6	2·24	7·53	6,371	5·53	·192	·334	1·46	70·65	18·06	·38	1·14
A_1..........	0–2	53·7	32·9	13·4	8·6	3·23	16·34	16,530	4·99	·354	·209	1·02	66·79	12·39	·69	·54
A_2..........	2–4	49·3	32·7	17·9	12·9	1·73	5·60	16,360	4·55	·135	·197	1·26	79·09	11·09	·19	·33
B_1..........	4–14	58·8	32·1	9·1	6·7	2·02	6·99	7,060	5·30	·111	·198	1·30	70·26	18·13	·44	1·24
B_2..........	14–24	68·2	26·5	5·3	3·6	·76	3·48	2,755	6·02	·045	·180	1·51	72·31	17·97	·56	1·11
C..........	24–	77·6	18·1	4·3	4·1	·38	2·87	2,410	6·30	·033	·162	1·26	72·91	17·74	·72	1·23
INTERVAL SILTY LOAM																
....	0–10	33	44·2	22·8	17·2	·98	5·71	2,410	5·97	·169	·218	1·47	71·32	19·13	·32	·87
....	10–25	29·4	49·8	20·8	12·8	·90	3·34	1,370	6·23	·071	·187	1·74	72·80	19·64	·48	·80
....	25–	31·4	52·8	15·8	13·8	·56	2·17	689	6·10	·050	·180	1·77	73·30	18·67	·47	·80

(a) On basis of oven-dry (105° – 110°) weight of soil.
(b) Lime requirement is expressed in pounds of ground limestone per acre.

SOIL MAP OF WOODSTOCK AREA
NEW BRUNSWICK

Scale: 1 Inch to One Mile

LEGEND

CLASSIFICATION OF SOILS

A Soils developed on glacial till

II KINGSCLEAR NACKAWIC ASSOCIATION

a Well drained soils

(1) Kingsclear clay loam

(1) Nackawic clay loam

II. PARRY MIDWAY ASSOCIATION

(1) Parry sandy loam

1 Midway series

(1) Midway sandy loam

IV BECAGUIMEC SNYDER ASSOCIATION.

Soils developed from modified, reddish brown sandy loam till derived largely from non calcareous Carboniferous sandstone and conglomerate

a Well drained soils

(1) Becaguimec sandy loam

b Ill-drained soils

1 Snyder series

(1) Snyder sandy loam

V PINDER ASSOCIATION

1. Pinder series

(1) Pinder loam

B Soils developed on water worked stratified parent materials

I GAGETOWN ASSOCIATION

Soils developed on gravelly outwash, kames, and eskers

a Well-drained soils

II RIVERBANK OROMOCTO ASSOCIATION

(1) Riverbank sandy loam

(2) Riverbank fine sandy loam

I INTERVAL ASSOCIATION

a Well drained soils (subject to periodic flooding)

Gravelly phase — contains more gravel than is ordinarily found in the soil (e.g. C.)

REFERENCES

Paved highway

Secondary

Railway

Building Dwelling

Isolated barn or abandoned dwelling

Sawmill